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EARLY DIAGNOSIS OF MALIGNANT GROWTHS WITH A BRIEF REFERENCE TO THEIR INCIDENCE IN INDIA*

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The importance of early diagnosis of malignant growths will be obvious to every one and as such no apology need be advanced for the choice of the subject. It appears to me that the best way to introduce the subject is by a brief reference to the incidence of malignant growths in our country

INCIDENCE

That malignant growth is very common in our country, as indeed it is all the world over, must be common knowledge to all medical men It occurs in all races of mankind, civilized or uncivilized, it also occurs in all vertebrate animals, wild or domesticated, carnivorous or herbivorous Cancer shows several common features—biological, clinical, macroscopical and microscopical—in man and animals (Gye & Hosford, 1936) While the great frequency of carcinoma is known to all, medical men do not probably all realise the magnitude of the incidence In countries where reasonably accurate statistics are available the condition is proved to be appallingly common Thus, in Great Britain it is estimated that more than 10 per cent of the people who reach the age of 35 eventually die of cancer (Statistical review for the year 1934 by the Registrar General) It has been said, and I think with a fair amount of justification, that statistics on Indian lives are so scanty and scrappy that reliance on them is bound to endanger one's conclusions (Minnoo-Masani) Even so, it need not be seriously doubted that malignant growth is a menace quite common in our country The incidence of carcinoma, according to statistics published in Western countries rise-

affected tissues that seems to play an important part in the origin of cancer Thus, among a race of people in whom the expectation of life is only 26, the tissues may be old at an early age I realise that such arguments may be fallacious for various reasons Thus for example, our average mortality is very high (22 per 1,000 of the population, the highest death rate in the world) and our expectation of life very low, mainly because of deaths due to preventible causes such as malaria, small-pox, dysentery, plague, filariasis, etc, and due to very high infant and maternal mortalities, which again are in the main preventible

The point I want to make out is this Unless statistics are collected from a very large series, we cannot have any exact idea as to the relative frequency of the disease We must know the type of cases that occur, the organs affected, the age, the sex incidence, etc There is reason to believe that the incidence in India, classified according to the viscera affected, is at variance in some important respects from the incidence in other countries To judge the correctness or otherwise of these ideas, an attempt has here been made to classify available information The biopsy reports on malignant growths from different representative institutions have been combined and classified—these have been obtained from various hospitals in widely different parts of this Presidency and nearby—Vizagapatam, Madras, Cuttack and Madura Each of these institutions is known to tap cases from a large area all around

No case without biopsy report has been included in the series Even cases in which clinically the diagnosis was beyond any reasonable doubt, have not been included in the review without biopsy, as this is the only sure, if not infallible way of ensuring accuracy.

The following tables show the analysis

TABLE I—SHOWING ANALYSIS OF TOTAL CASES

Total no of cases	% of total	Remarks
Carcinomas	940	86 2	The ratio between the groups runs parallel to that in other countries
Sarcomas	149	13 8	

TABLE 2—Showing Sex Distribution

Carcinoma	9-1	Male	5 4	(56 6 %)
		Female	4 0	(43 4 %)
Sarcoma	1-0	Male	100	(47 8)
		Female	49	(72 2)
Carcinoma & sarcoma	10 0	Male	601	(57 17)
		Female	450	(42 2)

TABLE 3—SHOWING ANALYSIS EXCLUDING CARCINOMAS PECULIAR TO MALES OR FEMALES AND TAKING INTO CONSIDERATION ALL OTHER CARCINOMAS ONLY [530 (49 7%) came under this group (leaving 559 in the group peculiar to sexes)]

Males	367—69 2%
Females	163—30 8%

TABLE 4—SHOWING CARCINOMA PECULIAR TO SEXES

	Sex	% of total cancer cases	% of all cancer cases in men	% of all cancer cases in women
Males	177	18 8%	33 3%	
Females	235	25%		55 4%

TABLE 5—SHOWING INCIDENCE OF CARCINOMA ACCORDING TO THE VISCERA AFFECTED AND THE SEX DISTINCTION IN EACH

Region affected	Male (531 cases) No of cases	Expressed in % of all carcinomas in male	Female (409 cases) No of cases	Expressed in % of all carcinomas in female	Male & Female together No of cases	Expressed in % of all carcinomas
1 In the region of the mouth i e lip, cheek, floor of mouth, tongue, palate, jaw, gum	124	23 3	51	12	175	18 6
2 Male reproductive organs	171	32 2				
Penis	154	29				
Testis	17					
3 Female reproductive organs			128	31 3		
Cervix uterus			80	19 6		
Body of uterus			12			
Ovary			25			
Vagina, clitoris etc			11			
4 Breast	6	1 1	107	26 2	113	12
5 Alimentary system						
Stomach	21	3 9	12	2 9	33	3 5
Rectum	38	7 2	7	1 7	45	4 8
6 Urinary system	8	1 5	3	0 7	11	1 2
7 Skin and appendages	58	19 2	32	7 8	90	9 6
8 Secondary deposits in glands	32		15		47	
9 Other organs	93	17 5	48	11 7	141	15
Total	563		424		987	
10 Excluding sec. glands cases	531	56 6	409	43 4	940	

Table 5 shows something very important to be taken note of Carcinomas in the region of the mouth (175), of male reproductive organs (171), of cervix and vulva (91), breast (113), rectum (45), and the skin and its appendages (90), together account for 585 out of a total of 940 cases All these above conditions require only the eye or the examining finger for a diagnosis, i e, *fully 62 2 per cent of cases are obviously visible or within reach of the examining finger* Yet, most patients put up with their discomforts for such a long time that by the time treatment is resorted to, the condition is so far advanced that cure in any sense is out of the question

TABLE 6—SHOWING CLASSIFICATION OF SARCOMA AND ITS INCIDENCE IN THE TWO SEXES

	Male	Female
Fibro-sarcoma	29	12
Spindle-celled	15	12
Mixed celled	8	10
Endothelioma of bone	3	
Ewing's tumour	4	
Lymphosarcoma	19	4
Osteogenic sarcoma	6	4
	(one in radius)	
Reticulo-sarcoma	3	
Neuro sarcoma	4	2
Round-celled sarcoma	6	2
Myxo-sarcoma		2
Brain sarcoma (meninges)	2	.
Synovioma knee	1	
Skin		1
Bladder	1	
	100	49
Gand Total	149	

To draw inferences from the above tables may be erroneous for, a total of even 1,089 cases is too small a number for purposes of consideration of a disease of such great frequency as carcinoma I have suggested a questionnaire (*vide* appendix) which, if sent not only to every member of the Indian Medical Association, but also to institutions and private bodies willing to co-operate in the work will, in the course of a few years yield an enormous amount of material from which accurate inferences can be drawn

However, the above tables do bring out certain features which require comment and call for future verification While the figures show that the proportionate incidence between carcinoma and sarcoma is the same as in other countries and incidence of carcinoma of the uterus, breast, larynx, etc., seem to correspond with the incidence elsewhere, some obvious differences are evident —

Thus, carcinoma of the stomach seems to be far less frequent here Of all types of cancer, our hospital statistics show the incidence of carcinoma of the stomach to be only about 3 5 per cent of the total, as against 22 per cent in Great Britain, 42 per cent in America, 55 per cent in Holland, Bavaria and Spain and 66 per cent in Czecho-slovakia (Illingworth and Dick, 1935)

Again some statistics of other countries show a very large incidence of lung carcinoma (Oschner A, and De Bakey, 1940) In these, the condition appears to be second to the stomach alone in the order of frequency Thus, in Scotland, the total deaths, from pulmonary cancer in the year 1940 was 559 (Robertson, 1945) Maxwell (1935) says that accord-
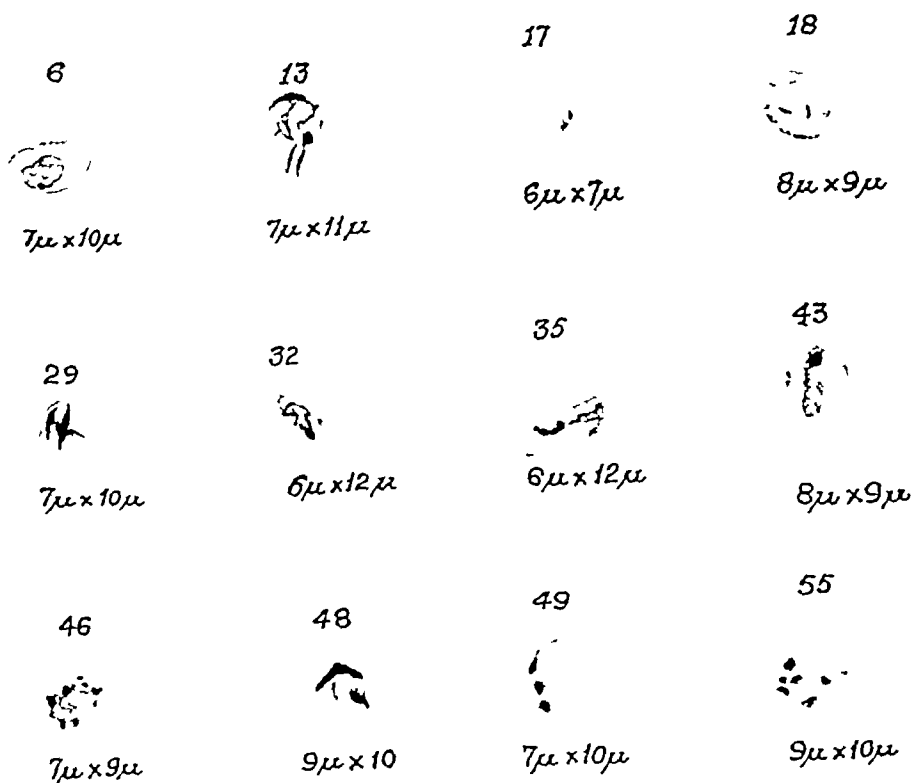
Twelve representative drawings of Plasmodium Ovale from a series of 58

Tyagi—Plasmodium Ovale Infection in U P
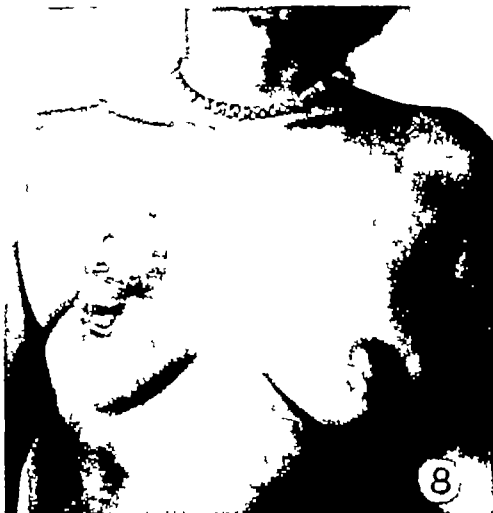
Fig 6 (Case 3)—Advanced carcinoma of the breast in which almost the entire breast has disappeared

Figs. 7 and 8—Cases of carcinoma of the breast   At such a stage. it is obvious that cure is out of the question

Fig 9—Very early carcinoma of tongue—a hard nodule of the size of a match head in a young woman of 25, (confirmed by biopsy)

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ing to most reliable statistics, carcinoma of the lung ranks next to carcinoma of the gastro-intestinal tract, breast and uterus   To quote Brock (1943) "Less than a generation ago primary carcinoma of the lung was thought to be a rare curiosity, today it is recognized as a common condition and ranks next to cancer of the colon in frequency in man"   He sees on an average some 75 cases each year   Lung cancer does occur here, but it seems to be very infrequent   It cannot be that the condition is missed for want of proper diagnosis If this was the case post-mortem records at least would show up some cases   Perhaps some racial peculiarity or a different environmental condition determines the frequency of a particular type of carcinoma in different parts of the world   Thus for example it is a general belief that tumours of the nasopharynx are uncommon, but this disease is particularly frequent amongst the Chinese at Shanghai and Hong-kong, as well as among the domiciled community in New York (Rao, 1944) Indeed *according to Digby and his associates (1941) tumours of the naso-pharynx rank, second in frequency in a list of all cases of malignant diseases*

The story of malignant growths is a pitiful and depressing tale of "too late and too little", "too late", as the patient in his ignorance reports for treatment when the condition is far too advanced for any treatment, and "too little" in results, as a direct consequence thereof   This seems to be the case, even in countries like America where facilities, both scientific and monitary, are so ample for an early diagnosis   In our country where facilities are as yet meagre and the people in the majority ignorant, medical help is sought only when the condition is far advanced

CASE REPORTS

Case 1—Figs 1 & 2 show an advanced case of malignant growth of the maxilla   It is obvious that nothing can be done in these cases

Case 2—Figs 3 to 5 show a case of carcinoma of the breast in a male with a big secondary deposit in the skull   Axillary glands of both sides were enlarged and hard   The patient had also hemiplegia of the right side, possibly due to the effect of secondary deposit in the brain   Biopsy report of the breast, as well as of the tumour of the scalp was, "adeno carcinoma

Case 3—Fig 6 shows a case of advanced carcinoma of the breast in which almost the entire breast has disappeared and there is extensive breast involvement of the area

Figs 7 and 8 show some more cases of carcinoma of the breast   In practice it is unusual to get cases rather than all   If cases come at such a stage, it is

the tongue   It was practically the size of a match-head and was excised with a good amount of healthy tissue all around (Figs 9 & 10) and submitted to biopsy The condition proved to be carcinoma and required more extensive operation or radiotherapy , but the patient refused treatment and went home   Attempts at follow-up of the case also failed   In another instance, a man of about 50 came with evidences of rapidly developing pyloric obstruction   Operation showed an early growth in the pyloric antrum   Subtotal gastrectomy was performed and pathological report confirmed the condition to be one of carcinoma   There was no evidence of secondaries and indeed this was the one case in my series where the enlarged lymphatic glands were limited to supra and sub-pyloric groups

As already mentioned, patients almost always come at an advanced stage of the disease due to their ignorance and poverty   Remedy for these involves large scale planning, improvement of social conditions etc , which are beyond the scope of this article   I propose to limit myself to the following, viz , when a patient reports himself to the doctor very early in the disease, so early that diagnosis is in doubt, how can the doctor set about to settle the diagnosis?

EARLY DIAGNOSIS

For this, first of all, I want to stress the following fundamental facts —

1   The cause of cancer is still unknown   All that we do know is, that *cancer at its inception is a local disease   Even the most malignant tumour is localised in the beginning and at this stage it may be cured by excision through the healthy tissues around*

2   Cancer in its early stage is painless   Pain indicates complication of some sort and often signifies a rather advanced stage   Pain may be due to ulceration infiltration, pressure on adjacent nerves, secondary deposits etc   Consequently, if cancer is to be diagnosed early, one ought not to look for pain as one of the evidences

3   Cancer does not arise in normal tissues   It arises in tissues already the seat of some pathological change, e g , leucoplakia of tongue, chronic ulceration dental ulceration, chronic cholecystitis associated with gall-stones, renal stones and leucoplakia of renal pelvis tears of cervix uteri, goitre, phimosis, etc , etc

4   Cancer spreads by direct extension into the tissues around and through related lymphatic and blood vessels   To judge whether a growth is malignant or not, the relation of the tumour to the surrounding tissues is most valuable and *for this reason it is most important to examine the entire tumour rather than the central part*

but the early features are often indefinite, and consequently their descriptions are also vague, while the late features are definite and unmistakable Graphic descriptions of these late stages are given which get fixed in the students' mind Perhaps it will be wiser to omit descriptions of these late stages altogether

7 The question of the age of the patient and duration of the disease should not unduly influence the diagnosis, i e, if other things point to a possible malignant condition, such a possibility should never be excluded merely because of the young age of the patient or long duration of the disease I know of a case of carcinoma of penis which occurred in a child of two, carcinoma of the rectum at thirteen, oesophagus at twenty,—all verified by biopsy Thus, once a question of malignancy arises, whatever the age or the duration verify with all the diagnostic aids, including biopsy, before a definite conclusion is arrived at

Some Salient Features

The following illustrative case reports bring out clearly some salient features to be remembered

DENTAL ULCER AND MALIGNANCY—(a) A dental ulcer usually heals in about a fortnight after the extraction of the offending tooth If it does not heal by that time, one should seriously review the condition and decide whether the ulcer is not associated with a malignant change If on palpation of the margin of the ulcer, a hard nodule is felt, it makes the suspicion almost a certainty This is so, even if the induration is over a minute spot only and the only way of settling the question is by a biopsy Here a word about biopsy Wherever possible the dental ulcer is better excised entirely together with a portion of the healthy tissue all around, and sent for biopsy If the ulcer is too large for this procedure, tissues from two or three different places at suspicious spots must be taken along with the adjacent healthy tissue, particularly from places which feel hard

May I add, here that one must get into the routine of always obtaining a pathology report on all tumours removed To arrive at conclusions from naked eye appearances alone will lead to disaster sooner or later Thus, a small nodule removed from the eye lid of a lady was found on a routine biopsy to be a hypernephroma There was no suggestion whatever of any kidney trouble On the basis of the pathology report alone the surgeon undertook an exploratory operation and detected an early hypernephroma of one of the kidneys and removed the kidney

(b) Again, a hard nodule even of the size of a match-head in the margin of a gummatous ulcer of the tongue is a warning that the ulcer is turning malignant Do not look for such conditions as difficulty in protrusion of the tongue, or of excessive salivation Such signs are evidences of advanced infiltration fixing the tongue and interfering with the normal swallowing of saliva

(c) If a leucoplakic patch of the tongue, lip or cheek becomes larger, thicker, or ulcerated, these are warning signs of transition to carcinoma

2 CARCINOMA OF THE BREAST—*In a middle aged woman, lump in the breast felt with the flat of the hand is likely to be a carcinoma, in 9 out of 10 cases* It is important to palpate with the flat of the hand and not pick up the breast substance with the tips of the fingers In the latter way many nodules may be apparent which are not pathological and a significant hard lump may be missed Such early signs as elevation or deviation of the axis of the nipple (even in the absence of retraction of the nipple) have great significance and can be appreciated only by comparing with the normal breast This is possible by examining the patient in a good light, in sitting posture, with the clothes taken off the chest Some patients are unwilling to be examined thus even by a lady doctor Imperfect and partial examinations of the breast in a shy patient will only result in missing an early growth If the patient is shy, it is far better to refer the case to a lady doctor and in any case it is wise to refuse to give an opinion unless complete examination is allowed It is interesting to quote here Bradfield's (1930) observation He states, "Formerly we have commented on the comparative rarity of cancer of the breast, but during the past year this belief has been upset, and suggests that there is a tendency for women to conceal the disease The statistics bear out what has been reported before, that the incidence of the disease is very much the same in India as it is in other parts of the world"

Incidentally, it is worth while remembering that if a lump is felt, but one is not sure whether it is a tense cyst or a solid substance, transillumination of breast may help It may show up a cyst clearly but where a cyst is present, it is unwise to be satisfied with tapping a cyst It is far better to excise it and examine it carefully, because the cyst may be the result of obstruction to the duct by an early growth

Where a lump is felt, but the diagnosis is in doubt, it is better to excise the lump together with the healthy tissue around with diathermy knife and submit to biopsy report Indeed, if at all there is reasonable evidence of malignancy and if the patient is willing a simple excision of the breast should be done If there is report of malignancy, a radical excision must soon follow Some delay is inevitable in adopting these methods To obviate this, the method of frozen section may be adopted, but this requires a trained pathologist who has wide experience with the interpretation of frozen sections In general it may be said that *it is advisable to make the diagnosis from examination of the primary growth alone and let the condition of the lymph nodes help in determining prognosis*

3 CARCINOMA OF STOMACH—Mere loss of weight and general debility may be the only symptom Indeed in a middle aged patient, where an obvious cause (e g, tuberculosis, anaemia due to ankylostomiasis etc) is not found to explain such symptoms, the possibility of carcinoma of the stomach must be seriously considered and every test must be applied to exclude or confirm the diagnosis

Achlorhydria or hypochlorhydria need not be present. Hypochlorhydria is the result of gastritis rather than directly of the cancer Patients with gastric cancer may be found to have free hydrochloric acid (Keynes, 1946) In many of Jussawall's cases a high free and total acidity was present, one case even showing a free acidity of 167 in the fasting juice (Jussawall s, 1947)

Place of Diagnostic Laparotomy—Where the various examinations leave one in doubt, it is the duty of the doctor to advise a diagnostic laparotomy This is perfectly justifiable and *it is far better to do it and find no growth than to wait and watch* If the latter course is adopted, it will be found that by the time the conditions becomes definite, it has also become inoperable

4 PILES AND CARCINOMA RECTUM—A patient may come with the complaint of bleeding per rectum If proctoscopic examination in such a case shows hæmorrhoids, it does not necessarily exclude a more serious condition above Carcinoma of the rectum may exist without any more evidence than bleeding during defæcation, from piles as a result of interference with venous return by the growth at a higher level *In no case should piles be treated as such in a middle aged or elderly patient without a routine sigmoidoscopic examination* Indeed, patients have come to hospital after operation done elsewhere for piles They came because their symptoms had not improved A digital examination in some of the cases has shown an obvious malignant growth low down and easily accessible to the examining finger and one wonders how the condition could have at all been missed, if a rectal examination had been done prior to operating on the piles

Rectal examination is one of the simplest and yet one of the most sadly neglected procedures Many a growth in rectum could easily have been diagnosed, weeks if not months earlier, if only the doctor had not neglected this simple but one of the most important of methods

Digital rectal examination is useful not only for local in growths in rectum but also growths higher up With the patient sitting and a finger in the rectum many a growth at the pelvi-rectal junction and in the pelvic-colon nearby may be felt In some cases with a finger in the rectum and a palpating hand on the lower abdominal wall of the recumbent patient, pelvic colon growth may be detected—by bimanual palpation In yet others instead of laying the patient right back or turned to left side as is often done if correct area is had in mind if the patient turned to the right Also position of growth in descend's of the

A word about stool examination—The mere evidence of chronic bacillary or amœbic dysentery does not necessarily exclude carcinoma Indeed, where an ulcer is felt in the rectum and at the same time amœbæ are found in the stool, if quick response to emetine injections is not obvious, it is wise to take a biopsy from selected areas of the ulcer margin *Dysentery may be superimposed on a carcinomatous condition* and this point should always be borne in mind

5 OTHER EXAMPLES—(a) *Brain Tumour*—One cannot go into details here but I want to stress on one feature viz, the significance of localized headache I quote the following "Localized headache sometimes appears as an early symptom without evidence of increased intracranial pressure A superficial tumour of the brain may cause localized neuralgic pain, usually associated with tenderness The meningiomas are especially apt to produce this symptom, and it is seldom absent when the tumour invades the skull Tumours of the posterior fossa, especially those in the neighbourhood of the foramen magnum, often produce pain in the suboccipital region and back of the neck as an early symptom Associated with this there is sometimes localized tenderness, and some degree of cervical rigidity The pituitary adenomas are apt to cause bitemporal or bifrontal pain of a boring character and often severe" (Symonds and Cairns, 1936)

(b) *Carcinoma of Larynx*—It forms about 2 per cent of all carcinomas in other countries and seems to be of similar frequency in our country also In a middle aged or old person, a hoarse voice or change in the voice not due to any ascertainable cause and not clearing up in three weeks by ordinary methods may be due to carcinoma larynx and every method of examination must be adopted before the condition is confirmed or ruled out *It is all the more important to diagnose this condition because in no other region of the body are the chances of permanent cure of cancer by surgery more hopeful than in this condition* (Rao 1941 1944 1945) The same author deplores that the large majority of these patients come too late for any hope of cure

(c) *Goitre becoming Malignant*—A goitre may become malignant several years after its existence, and the long duration of a goitre should not influence one in regarding a possible malignant change Further, it cannot be too strongly emphasised that *cancer, to be cured later, carcinoma of thyroid is often slow in its growth* Pain radiating to the neck and head, an increase in hardness or size of a nodule, dysphagia —all must be seriously treated as evidence of malignancy Under these circumstances it is far better to remove the thyroid gland than to wait and see

(d) *Breast and a fibroma*—Under...

(e) *Mole*—If a mole becomes larger in size or ulcerates or bleeds easily or becomes painful, think of the probability of its turning malignant

(f) *Carcinoma Penis*—Urethral discharge in a phimotic prepuce has been treated more than once as gonorrhœa The correct thing is to slit the prepuce and see and in doubtful cases biopsy from indurated areas must be taken In fact in the majority of such cases, on slitting the prepuce, if a carcinoma is present, there are unmistakable evidences of it *The condition is missed simply because so simple a procedure as slitting the prepuce and seeing the glans is not done* Indeed, in such cases, palpation will give unmistakable evidences of it even before slitting If there is a nodule or leucoplakic patch in the prepuce, it is best to circumcise and get a biopsy report of the suspicious areas In cases with growth inside a phimotic prepuce there is often a characteristic dumb-bell shaped appearance of the glans which is unmistakable

PLACE OF X-RAYS

While skiagrams may be of great help if properly interpreted, the findings from these should not ordinarily be allowed to exclude the diagnosis of a malignant growth, if clinical features point to such a probability For example, the mere absence of a filling defect in barium-meal skiagrams should not exclude a carcinoma of stomach or colon, if clinical features suggest these conditions *In such cases the next step must be by an exploratory laparotomy*

PREVENTION OF MALIGNANT GROWTHS

The supervention of malignant growths on certain pathological conditions, can be prevented, by what may well be called prophylactic operations A timely removal of a leukoplakic patch of the tongue, extraction of a carious or irritating tooth or stump, early treatment of pruritis, vulvæ and leukoplakia of vulva (Watson and Gusberg, 1946), removal of goitres, excision of large moles, removal of gall stones and renal stones, prevention or proper treatment of chronic ulcers, proper treatment of tears of cervix uteri and erosions of cervix, circumcision of phimotic prepuce, removal of papilloma and adenoma in rectum or colon etc will go a long way in the prevention of malignant growths

SOCIAL WORK

A large number of the poorer class of patients of both sexes in the area of Vizagapatam and other parts of Andhradesa are inveterate smokers Leukoplakia and cancer of the hard palate are very much more common in women who smoke with the lighted end of the cigar inside the mouth, evidently to escape notice and the social stigma attached to smoking amongst women (Rao, 1944) Incidentally, the same author stresses on the relation of smoking to carcinoma of laryngo-pharynx He says that the evidence is too strong, both experimental and clinical indicating smoking as an extrinsic factor of great importance

(Rao, 1941 and Flory, 1941) These examples suggest the line on which social work may be undertaken towards the prevention of malignant growths

CONCLUSION

The conclusions in the main are as follows —

(1) There is reason to think that while carcinomas are as frequent in our country as in other parts of the globe, there seems to be some important differences in the incidence as classified according to the viscera affected These are fully discussed A plea is made for collecting statistics on a much wider scale than now, so that reliable conclusions can be drawn

(2) One of the few favourable features of even the most malignant tumour is their local origin and it is upon this that the whole treatment of cancer *by surgery is founded*

(3) Fully 62 2 per cent of the growths occur in regions easily visible to the naked eye or accessible to the palpating finger

(4) Omission of such simple examinations as a digital examination of the rectum or sigmoidoscopic examination is responsible for missing early recognition of at least some of the cases of carcinoma rectum, colon etc.

(5) Pain is not a feature of carcinoma anywhere, in the absence of complications

(6) Such considerations as young age of the patient, very short or very long duration of the disease, negative x-ray findings etc. should not be allowed to exclude a malignant growth, if other features point to it

(7) The place of exploratory operations for diagnostic purposes is discussed

(8) Pre-cancerous conditions properly treated can go a long way in preventing incidence of malignant growths

(9) At present, the majority of cases came too late to be benefitted by any treatment The main reason for this is ignorance on the part of the patients No improvement can occur until the general level of education, social condition etc of the entire mass improves

QUESTIONNAIRE FOR COLLECTING STATISTICS OF MALIGNANT GROWTH

1 Serial No

2 Name

3 Sex

4 Age

5 Address

6 Occupation

7 Where treated

8 Disease

9 Duration

10 Pathological Report

11 Remarks

(a) Details of all cases where confirmatory biopsy reports are available, are requested in a tabular form as given above.

(b) Give separately details (similar to above) of cases which were clinically definite but no biopsy was done

(c) In remarks column, mention any factors of importance, e g presence of phimosis in carcinoma of penis, any suggestion of occupational relationship to the disease, habits etc. e g smoking with burning end of the cigar inside the mouth in cases coming with cancer of palate.

(d) Wherever possible, please send clinical photographs, reprints of skiagrams, microphotographs of pathological sections etc.

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ON THE CHEMISTRY OF ANTACIDS

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Antacids are substances used in medicine for the neutralisation of gastric acidity Hydrochloric acid is a normal constitutent of gastric juice and its presence enables pepsin, another constituent of the same, to digest proteinous food materials The concentration of hydrochloric acid in the freshly secreted juice (Starling, 1936) is 0 5 to 0 6 per cent (0 138 N to 0 165 N) But the strength of the acid is reduced by reaction with (a) mucus which is secreted along with gastric juice, (b) proteins derived from food and their digestion products, and (c) alkaline substance of the duodenum which is regurgitated through the pylorus Reduction of its strength is also effected by dilution with the liquid taken along with the food The resulting concentration is variable, but analysis of normal chyme withdrawn for gastric analysis has been found to show 0 1 to 0 2 per cent (0 027 N to 0 055 N) of the acid (Wiggers, 1934) Hyperacidity is generally caused by the deficiency of one or several of the factors which normally act to dilute or neutralise secreted gastric juice, or by such factors as increased rate of secretion of normal gastric juice and delayed gastric evacuation In hyperacidity, the free acidity of the chyme approches that of the pure gastric juice, and the increased concentration of the acid often leads to irritation and spasm of the stomach muscles, commonly recognised as the familiar heart-burn and stomach pain Hydrochloric acid at this concentration by itself has no harmful action on the gastric mucosa, but pepsin in the presence of about 0 1 N hydrochloric acid has a considerable destructive action, particularly on damaged or ulcerated tissues In cases of peptic ulcer the presence of acid not only causes irritation but inhibits the growth of the granulation tissue thereby delaying the process of healing The administration of antacids is, therefore, frequently resorted to for relieving the distressing symptoms of hyperacidity as well as for controlling the acidity in the treatment of peptic ulcer

Theoretically speaking an substance which can neutralise hydrochloric acid without being poisonous to the system, may be termed an antacid But important differences exist between one antacid and another, e g in the rapidity of neutralising action, in the pH to which it can raise the stomach contents and in the physiological actions of the substances themselves as well as of the products of their reactions with the acid in the gastric juice and with the alkaline substances in the intestines A clear understanding of the chemical physicochemical and biochemical characters of a antacid of course

lows the electropositive character of the metal For this reason, alkalis (e g, sodium or potassium), as a rule, provide stronger antacids than the alkaline earth metals, (e g, calcium or magnesium), and the latter are again stronger than aluminium or bismuth Oxides or hydroxides of metals are generally more reactive than the corresponding salts, and only salts of weak acids, which show little acidity in the free state, can function as antacids An important factor governing the rate of neutralisation of an antacid, however, is its solubility in water, since the interaction takes place only in solution For sparingly soluble substances, the available surface area determines the rate of solution, and the fineness of the powder is, therefore, of importance. The solubilities in water of a number of common antacid substances are given in Table I

TABLE I—SHOWING SOLUBILITIES OF ANTACIDS

Substance	Chemical formula	Solubility Parts per 100 parts of water	Remarks
Sodium bicarbonate	$NaHCO_3$	6 9 at 0°C 16 4 at 60°C	
Calcium hydroxide	$Ca(OH)_2$	0 185 at 0°C 0 77 at 100°C	
Magnesium hydroxide	$Mg(OH)_2$	0 0009 at 18°C	Solubility products $= 10^{-n}$
Calcium carbonate	$CaCO_3$	0 0065 at 20°C 0 002 at 100°C	
Magnesium carbonate	$MgCO_3$	0 0106 at 0°C	
„ hydrate	$MgCO_3, 3H_2O$	0 1518 at 19°C	
Bismuth carbonate	$Bi_2O_3CO_2 H_2O$	?	Practically insoluble in hot and cold water
Aluminium hydroxide	$Al(OH)_3$	?	Solubility product $= 10^{-n}$
Aluminium phosphate	$AlPO_4$	?	Practically insoluble in hot and cold water

Obviously, sodium bicarbonate should have a more rapid neutralising action than calcium or magnesium hydroxide, and the latter again more than aluminium hydroxide. The alkaline earth carbonates neutralise acid with moderate speed, but bismuth carbonate which can react with concentrated hydrochloric acid, does not practically react with the low concentration of the acid as present in the stomach

pH OF NEUTRALISATION

When an antacid is added to hydrochloric acid, the pH of the solution gradually increases as the neutralisation proceeds, and the end-point of the reaction is indicated by a rapid rise in the pH Fig 1 contains curves showing the changes of pH of a 0 1 N hydrochloric acid solution consequent on the additions of varying quantities of a few typical antacids These show that milk of magnesia $[Mg(OH)_2]$ causes a steeper rise of pH at neutralisation than sodium bicarbonate, and renders the solution highly alkaline on the addition of even a slight excess With magnesium trisilicate, the pH remains near about 6 0 after the addition of a considerable excess, but colloidal aluminium hydroxide raises the pH only up to 4 0 and maintains it at that level often after further additions

Usually, the dose of an antacid is so adjusted as to leave an excess after neutralising the acid in the stomach Since the actual quantity of the acid is variable, an idea of the conditions existing in the stomach after the administration of the antacid would be obtained by determining the pH of aqueous solutions or suspensions of antacids after the addition of varying amounts of hydrochloric acid The curves obtained in this manner for a number of antacids are given in

* Unpublished data from this laboratory

Fig 2 The flat portions indicate the pH values of antacid-hydrochloric acid mixtures when the former is in excess The pH levels for the different antacids are in the order .

$$Mg(OH)_2 > Mg_2Si_4O_4 > MgCO_3 > NaHCO_3 > CaCO_3 >$$

$$Al(OH)_3 > Bi_2O_2CO_2.H_2O$$
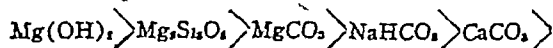
It should be remembered that the pH values were obtained after allowing sufficient time after each addition of acid for attaining equilibrium conditions, and therefore the consequences of differences in the rates of neutralisation are not evident from these curves For example, magnesium trisilicate is known to be a slow-acting antacid (Mutch, 1936) and hence the pH of the solution immediately after each addition would be much lower than shown here. Aluminium hydroxide shows as before its characteristic buffer action near pH 4 0

Doubt has however been expressed as to whether the neutralising actions of antacids as found by in vitro-experiments would correspond to these in vivo Breuhaus and Eyrly (1941) concluded from determinations of the pH of stomach contents in situ by introducing a special glass electrode into the stomach that the degree of reduction of gastric acidity accomplished by an antacid cannot always be predicted from its potential neutralising power as determined by titration They found that in most cases the increase of pH when determined in situ is surprisingly small On the other hand, Rosette and Flexner (1943) observed with a continuously recording pH meter, both in vitro and in the human stomach, that both methods gave almost identical results It seems probable that non-attainment of equilibrium between the antacid added

and the whole of the acid contained in the stomach would lead to such discrepancies between the *in vitro* and *in vivo* experiments
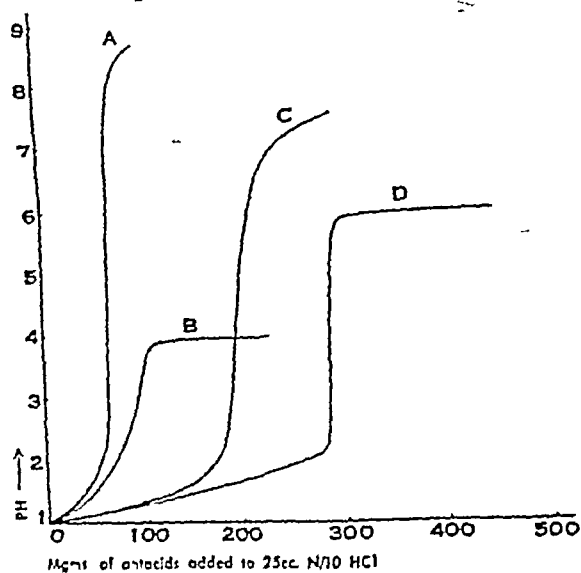
Fig 1—A—Magnesium hydroxide. B—Aluminium hydroxide. C—Sodium bicarbonate. D—Magnesium trisilicate
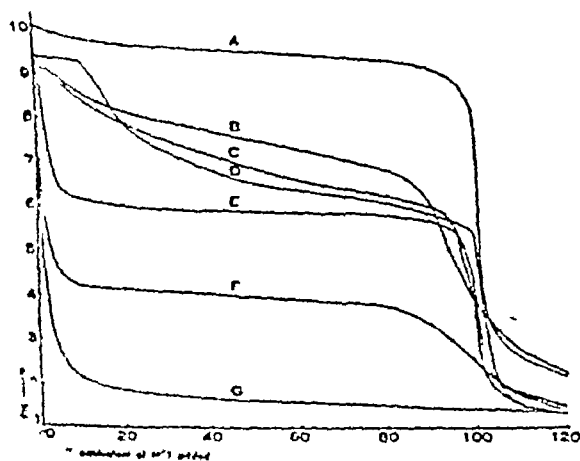
Fig. 2—A—Magnesium hydroxide. B—Magnesium trisilicate. C—Magnesium carbonate. D—Sodium bicarbonate. E—Calcium carbonate. F—Aluminium hydroxide. G—Bismuth carbonate

As the pH of the stomach juice can be raised to any degree by the addition of one or other antacid it is for the clinician to decide on the type of antacid required according to the condition of the patient It may be recorded here that complete neutralisation, i.e. to pH 7.0, or raising the pH into the alkaline zone is considered undesirable because such conditions simulate further secretion of gastric juice this being very bad for the normal acid condition Besides this it is more than an acid condition in the stomach is necessary for peptic digestion On the other hand Schiffrin and Warren (1942) showed from experiments on cats that below a pH 2.24 pepsin has no effect Given Kerr (1943) noted that pepsin would be inactivated temporary arrest or decreased activity

in man at pH 3.5 to 4.0 It is now being generally accepted that a pH of 3.5 to 4.0 would be harmless to the ulcerated tissues and would at the same time provide a sufficiently acid medium for peptic digestion to proceed.

Having decided what pH is the most desirable, the problem remains, how to attain this in practice It would be seen from the curves in Fig 1 that for neutralising 25 c.c. of a 0.1 N hydrochloric acid to pH 3.5, the quantities of different antacids required are $Mg(OH)_2$—60 mgm, $Al(OH)_3$—102 mgm, $NaHCO_3$ —198 mgm, and $Mg_2Si_3O_8$—288 mgm But if the quantity of the antacid added be in excess of these amounts by only 10 mgms, the pH of the solution would be $Mg(OH)_2$—7.6, $Al(OH)_3$—3.9, $NaHCO_3$— 5.9, and $Mg_2Si_3O_8$—5.85 This shows that except for aluminium hydroxide, the dose of the antacid would need accurate adjustment in order to bring the stomach pH to the designed level But this presupposes a knowledge of the exact quantity of free hydrochloric acid present in the stomach at the time, and the difficulty, nay, impossibility of such adjustment should be apparent when it is remembered that this quantity (and type) of acid is not known with any degree of certainty The only practical course would be to select an antacid which, even when present in excess, would maintain this pH, and obviously, the choice would fall on aluminium hydroxide Magnesium trisilicate, which shows a relatively high pH under ordinary conditions, would also register a somewhat lower pH under ordinary conditions due to the slowness of its neutralising action and would be expected to produce a pH not far from the optimum value.

SUBSIDIARY EFFECTS

It has been pointed out already that although acid neutralisation is the main function of an antacid, some other physiological factors have also to be taken into consideration for its selection The more important of these are :

1 Effect on the acid-base balance of the blood
2 Mechanical protection to damaged tissues
3 Gas formation
4 Stimulation of secondary acid secretion
5 Adsorption of toxins
6 Peptic inhibition
7 Action on the bowels

Acid-base balance—The pH of the human blood is delicately balanced between the values 7.33 and 7.51, and the extreme limits compatible with life are 7.0 and 7.8 (Sherman, 1937) This constancy of pH is attained through the agency of buffer systems in which alkali metals constitute the base. When alkali metal compounds eg., sodium bicarbonate, are taken as antacids, their absorption from the intestines into the circulation tends to alter the alkali content of the blood and thereby to disturb the acid base balance The too enthusiastic use of alkalis in large doses is therefore considered undesirable as it may lead to alkalosis

Adsorption—Muir (loc cit)

detoxicant if taken in sufficient doses so as to pass undecomposed into the intestines   Aluminium hydroxide and possibly magnesium hydroxide also possess adsorbing powers to a greater or less extent

Mechanical protection—In gastric ulcer, the lesions need protection from the corroding action of acid and pepsin   Bismuth carbonate and also the subnitrate are often used for this purpose, as these have the property of forming an impervious coating on the stomach linings   But these exert no antacid action   A similar protective action is also afforded by colloidal or gelatinous antacids, *e g*, cream of magnesia and the hydroxide (Woldman and Polan, 1939), phosphate or silicate of aluminium, which are doubly helpful, as they reduce the acid concentration as well.

Gas formation—Carbon dioxide gas is evolved by all carbonate or bicarbonate antacids on reacting with the acid in the stomach, and such antacids are contra-indicated where gas formation is undesirable

Secondary acid secretion—When the stomach contents are suddenly neutralised or rendered alkaline by the administration of antacids, a secondary secretion of acid takes place, known as "rebound acidity"   According to Opizzi (1944) some substances have a short neutralising effect but produce a secondary increased acidity, *e g*, $NaHCO_3$ and MgO, others have the secondary effect without initial neutralisation, *e g*, $CaCO_3$, Na_2HPO_4 and Ca_3PO_4 and good neutralisers without much secondary action are $Mg_2Si_3O_8$, $Mg(OH)_2$ and $Al(OH)_3$

Peptic inhibition—The corroding action of pepsin on the ulcerated parts of the stomach can be controlled by reducing the acidity, but certain antacids, *e g*, $CaCO_3$, $Al(OH)_3$ and $Mg_2Si_3O_8$ are believed to possess specific pepsin inhibiting effects (Warren *et al*, 1943)   For the same pH, $Al(OH)_3$ exerts a greater inhibiting action than $CaCO_3$ The phenomenon appears to be related to the adsorption of the enzyme on the antacid

Action on the bowels—Milk or cream of magnesia is well known for its laxative property   Bismuth carbonate, calcium carbonate and aluminium hydroxide on the other hand exert a constipating action.

Some Modern Antacids

The present day trend in the field of antacids is to control the acidity so as to maintain it at the optimum level, at the same time avoiding the undesirable side effects   Buffer systems consisting of alkali salts of weak acids, *e g*, sodium acetate, trisodium citrate and disodium phosphate are often used in place of the bicarbonate   Synthetic calcium silicate (Pedersen, 1942) and tricalcium phosphate are also sometimes administered   Magnesium trisilicate and colloidal aluminium hydroxide may be regarded as the most prized antacids of the present time (Shiffrin and Warren, 1942, Wyllie, 1940)   The former is now included in both the British and United States pharmacopoeias and the latter finds a place in the U S P XII   The characteristics of magnesium trisilicate from the pharmacopoeial standpoint have recently been discussed by Mukherjee *et al* (1946)   Aluminium

hydroxide, both in the gel and powder form, has a tendency to lose its acid neutralising power (Johnson and Duncan, 1945) and great care is necessary in choosing the right type of the medicament.   Other aluminium salts, *e g*, the phosphate, and silicate in the gel form have been suggested as alternatives to the hydroxide, and perhaps the latest in the field is aluminium amino acetate (Krantz *et al*, 1944) which is administered in the dry form   Milk has long been known to have a   soothing and   beneficial action in hyperacidity and is now often given with other antacids, *e g*, calcium carbonate or aluminium hydroxide (Breuhaus and Eyrly, *loc cit*, Rosette and Flexner, 1944)   Very recently even aminoacids have been recommended for use as antacids (Devy and Silver, 1943) on account of their amphoteric character

Conclusion

It is often found that any single antacid fails to satisfy all the requirements of the patient, and combinations of antacids are given to remedy this drawback.   Thus, a little quick acting antacid is added to a slow acting one in order to give immediate relief to a suffering patient   Similarly,   an   antacid   having laxative action may have to be added to another having astringent properties   For example, it has been suggested (Rosette and Flexner, 1944) that a combination of 4 0 c.c. of milk of magnesia with 200 c.c. of colloidal aluminium hydroxide prevents the undesirable rise of pH caused by milk of magnesia and the constipating effect of aluminium hydroxide.   It is possible to prepare any number of combinations of antacids by varying the ingredients and their proportions, and the number of such preparations in the market is swelling rapidly   Combinations of antacids with a variety of other drugs are also being offered   But a knowledge of the fundamental properties of the antacid substances, chemical as well as physiological, would be the surest guide for making the right choice.

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BRAIN WAVES

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INTRODUCTION

Pinel, the great alienist of his days, considered stomach to be the primal seat of insanity. Poets and philosophers sang the superiority of the heart over all other viscera of the body. To the heart were attributed all the afflictions of love and hate, of emotion and impulse. It was the guide and the conductor of the human orchestra till Robert Burton, several centuries ago, approached nearer truth and came to regard the brain as the chief organ. Many were the speculations on the location and process of thought in days gone by, and though it may appear ridiculous, scientists are still groping blindly for the answer. Methods of introspection, the Gestalt psychology, psycho-analysis, behaviorism, conditioned-reflexes, have all contributed much of value, but we are still very far from a clear conception of the functioning of the brain. So little, in fact, is known about its functioning that minute anatomy instead of real physiology fills the pages of the standard text-books of the day

Such a state of intellectual stagnation through dearth of knowledge among neurologists makes any substantial work in this direction of the utmost importance. And such an advance has been achieved in recent years through a study of the electrical changes that take place in the cerebral cortex

BRAIN WAVES

The brain, the most complex organ of the body, works silently, and, unlike the heart, without mechanical movements. Like the heart, however, it generates electricity, which can be detected, recorded and even interpreted. This electrical activity produces rhythmical waves of potential variations at characteristic frequencies. These are conveniently termed 'brain waves'. Being first discovered and recorded by Berger, they were earlier referred to as 'Berger waves'. On the other hand all modern references to the subject have been made under the caption of 'electroencephalography'

Technique of recording —These cortical potentials of the brain through complicated electrical instruments and technique borrowed from radio and television are recorded from the surface of the scalp with to a comfort or inconvenience to the patient

Electrodes are applied to the scalp at regions of interest and led off through amplifiers consisting of thermionic valves to the oscillograph

Prof. Berger used needles which he attached to the scalp after local anaesthesia. Mennasco and his associates used to do the method of Berger another an application of unpolarisable electrodes to the scalp

The graphic record obtained in this manner represents an apparently complicated series of oscillations. But the waves and the patterns that they form are by no means random. Certain wave-lengths and certain definite rhythms strongly dominate the usual records. Voltages are circumscribed within quite definite limits

As the most constant characteristic of an E E G we come across the frequency of the alpha waves, which is 8-10 per sec. These waves are of a maximum potential of 0 2 millivolts. This rhythm is remarkably constant in a given individual, maintaining the same level during the entire duration of the recording. In addition, waves of a greater frequency (17-30) per sec) but a smaller amplitude which are superimposed on the first, can also be differentiated and are known as beta waves

The waves are largest when needle electrodes are pushed through the scalp in a region where the skull has been removed, thus strongly suggesting that they arise in the brain. Besides, they are dependent neither on respiration nor on pulsation, and consequently they must be an electrical rhythm of the cerebral cortex.

Prof Dr Hans Berger of Jena who is the inventor of the electroencephalogram, on the basis of his original observations regarded the alpha waves of the E E G., popularly called "Berger waves" after his own name to be due to synchronised rhythmic discharges from neurones mainly in the visual area of the occipital cortex. The waves, as originally observed by him were present only in the absence of visual activity—appearing normally when the eyes were closed and disappearing as soon as they were opened. The essential condition for the presence of the waves was that the central part of the visual field must be uniform. These waves disappeared by the presence of a pattern.

It was explained that the Berger waves originated from occipital cortex undisturbed by any visual afferent impulses. Any form of visual activity broke up this regular pattern into a complex mosaic of asynchronous discharges and the rhythm was lost

This view was later supported by Adrian and Mathews who similarly assumed that the alpha waves originated in the occipital cortex only. Dr Berger however published a further report on his investigations in 'Forschungen und Fortsschritee' in which he expressed his opinion that the electroencephalogram and its greater oscillations the alpha waves develop in man throughout the cerebral cortices and not as Adrian and Mathews continued to maintain, only in the occipital cortex

It may be pointed out here that even the earlier reports of Berger mention that alpha waves were obtained on the application of electrodes to the scalp of the man preferably, to the occipital region. Reports from other workers and Berger himself have long ago settled the point of discussion beyond dispute

In the report already referred to, Berger further elaborated his conclusion. He rejected the view that brain waves according to him the result of electrogenic activity were due to

expression of psychophysiological action in the cerebral cortex He inclined towards the assumption, (based on experiments carried out by Dusser and Barenne and Mac Culloch), that the alpha waves develop in the three lowest cell layers of the human cortex, the so-called corona radiata He also believed that many of the lesser, briefer' oscillations of the electroencephalogram are produced in the uppermost cell-layers of the cortex, the superficial zone Numerous anatomical, physiological and pathological observations attest to the specially close inter-relation of the superficial zone and psychic activity Berger sought to establish this region as the place of origin of beta waves of from 11 to 24 angstroms The relation of beta waves with psychic function has been evidenced convincingly by indicative alterations in the beta waves under a diversity of psychic phenomena

There is one place where Berger's idea can be said to have been misconceived He, in another paper read at the International Psychological Congress in Paris in 1937, reported that there existed only a single electroencephalogram for the entire brain This would imply that the bio-electrical activity is the same in all parts of the cortex

Prof A Baudoin and his co-workers presented a paper in which their study of the question failed to corroborate the observations of Berger They presented an elaborate discussion based on experiments using multiple electrode-amplifier-oscillographs for different regions They found, for example, that the activities of precentral and occipital regions were independent even though both the regions are the seats of alpha waves which coincide only occasionally Homologous regions at the two hemispheres may give rise to tracings which resemble one another, but they were without total concordance in the time of acceleration of alpha waves The conclusion from these observations is that all cortical nerve areas have their independent electrical activities, but that the latter are more or less coordinated

We see thus, that the complex and apparently inapprehendable graphic records are no more meaningless tracings of cortical potential variations

We have not only distinguished certain characteristic regularities in the form of alpha and beta waves, but we have been able to establish their relation to the lower cortical activity (in corona radiata) and higher psychical functioning (in the superficial zone) We have, besides, known that each cortical nerve region has its own independent bioelectrical activity

We should, however, remember that we have done very little The elementary classification of waves and their tentative interpretation does not mean more than mere familiarity with the graphs Yet, even with this minimum familiarity with the vastly complex electroencephalogram, we have gone ahead to the application of the elementary knowledge we have with advantage to human problems The huge amount of subsequent work on this subject has been done mainly keeping this in view During this work the observations and conclusions just mentioned are automatically confirmed,

as indeed the work is based on their preliminary assumption. In fact routine electroencephalographic investigations in a few advanced hospitals are being carried out on a regular basis and are proving useful

From the brief discussion that follows, of the recent advances in this direction it will be readily understood that the work that has been done by different authors does not throw much light on the nature of these waves, being mere correlation of apparent irregularities in the electroencephalogram with a supposed corresponding clinical condition

APPLICATION OF ELECTROENCEPHALOGRAPHY TO HUMAN PROBLEMS

The rough idea that we have of the *normal* electroencephalogram in a healthy individual leads us to a study of any apparent irregularity and its interpretation in healthy as well as diseased subjects

Marinesco and his associates studied the general aspect of this problem They regarded as anomalies, considerable diminutions and augmentations which occur transiently in the course of recording On the other hand, the amplitude of the waves varies considerably in the course of recording They found that in some pathological cases the anomalies of the electroencephalogram consisted specially in modification of the amplitude (epilepsy and tetany) or of the amplitude and of frequency (aphasia, cerebral tumours) and so on The pathological cases with modifications of the frequency but without changes in the amplitude are extremely rare, nevertheless there are exceptions In some of the reported cases of aphasia, for example, frequency alone was diminished, likewise in dementia In two cases of cerebral tumours an augmentation of frequency without modification of amplitude was encountered

The general aspect of these irregularities having been thus worked out by Marinesco and his associates, other workers in the field were not wanting to contribute their toil in the respective diseases peculiar to the brain Major contributions were accordingly made in the field of epilepsy and intracranial tumours and lesions

I *Epilepsy*—The pioneers in the field of epilepsy are Gibbs and Lennox of Boston They electroencephalographed more than 400 patients and discovered several new facts about epilepsy, leading to improved diagnosis of epilepsy and an increased understanding of the nature of epilepsy and its genetic characteristics An epileptic seizure, whether a generalised or a brief lapse of consciousness, is almost always accompanied by dramatic changes in the electroencephalogram The convulsive seizure is associated with the appearance of sharp fast waves of moderate to high voltage in rapid sequence with, or without, the presence of slow large voltage flat-topped waves (often called delta waves) in addition It is most significant that these successive electric discharges, obviously the picture of overactivity, usually begin many seconds before the muscular movements or loss of consciousness Besides, the epileptic patient between seizures frequently

shows in the electroencephalogram 'spikes' or runs of fast waves resembling the preliminary outbursts that precede his convulsion but without signs or symptoms associated with them The patient is unaware of them but they are diagnostic of a susceptibility to seizure, and in a patient subject to seizures an increase in number and intensity of larval outbursts may give warning of an approaching convulsion hours or even days before The abnormal rhythms are thus clearly the *cause* of seizure and certainly not the effect The more fundamental basis of disorder, however, is not the abnormal rhythm but rather a defective control of rhythm Gibbs and Lennox, therefore, conclude confidently that epilepsy is the expression of improper functioning of the rhythm-regulating mechanism of the brain In short, the pathological physiology of epilepsy is a paroxysmal cerebral dysrhythmia. Golla, Graham and Walter, who are the other workers in the field, however, adopt a more cautious attitude towards the problem They considered that 'no definite pronouncement was possible as to the significance of the delta-wave foci in epilepsy' Their observations however, corroborate those of Gibbs and Lennox, and therefore do not leave much doubt as to the validity of their conclusion

Both groups of workers are in accordance regarding the fact that the form of these abnormal rhythms is distinctive for the *three main clinical types of seizures*—petit mal, grand mal, and the psychomotor type

The loss of consciousness for only a second or more with or without minor muscle twitches of the face and the eye, known as the petit mal, shows large slow waves at a frequency of almost exactly three a second with one or several sharp 'spikes' alternating, this being the most characteristic pattern of petit mal

A grand mal or a major convulsion is preceded by an outburst of fast waves with a frequency of 10 to 30 per second With the onset of the seizure the voltage rises Between the fits slow waves of large voltage—the delta waves—appear Abnormal rhythm preceding these and even other types, commonly appear first in the frontal area, but may even arise first in the parietal or occipital areas

It should be emphasised that although typical patterns may be described as corresponding to grand mal and petit mal respectively, it is seldom so clear and simple Most actual seizures are composite and show a mixture of grand mal and petit mal patterns

The third variety of seizures, called the psychomotor type in which the patient does no completely lose control of himself or become unconscious has own its own characteristic rhythm It is primarily a slow rhythm, about six a second and the waves are often sinusoidal and monophasic Patients whose fits are symptomatic or hysterical gave normal records

Many varieties of electrical patterns and many gradations of off and on established in our own area and the clear d ... electric pe ... ... cal nu... ... of ... merge gradually in ... what are called

'generally dysrhythmic electroencephalogram and behaviour problem individuals'

There is a significant group of men and women who never have had seizures but show the same types of dysrhythmia as described Irregularity of electric activity in them is certainly not epilepsy but it reveals the soil in which the epilepsy grows It is suggested that it is primarily those with the dysrhythmic electroencephalograms who develop secondary or symptomatic epilepsy following an injury to the brain (Lennox) Equally important is the fact that cerebral dysrhythmia is a hereditary characteristic that is almost always found in the epileptic himself and among his relatives Here apparently is the hereditary element in epilepsy— the potentiality for seizures—that is far more common and widespread in the population than the incidence of actual seizures (Gibbs)

In these works on epilepsy we not only see the dreams and prophesies of Berger coming true but even much more than that Not only the *different clinical types can be diagnosed correctly*, but *seizures predicted, hysterical and symptomatic fits differentiated*, and the *susceptibles picked* out from a pack of apparently healthy people

Treatment of Epilepsy—And finally, electroencephalography may be useful in the treatment of epilepsy

In one instance, reported by Gibbs and Lennox where the abnormal rhythms were confined to the frontal area, the interior portions of both frontal lobes were removed, with subsequent virtual disappearance of abnormal rhythms and great improvement in seizures It is only a solitary instance of surgical interference with the help of electroencephalogram On the medical side it is bound to be a greater importance Not that by itself it is in any way a cure, but it may be used to determine what drugs and what dosages are best suited to the need of a particular case The number and prominence of larval subliminal episodes are greatly reduced in most cases by appropriate medication But, instead of waiting for weeks or months to determine the effectiveness of different combination or altered dosages, we may now gain an indication in a few hours, or at the most a few days, of the effectiveness of the medication by simply observing the degree of stabilisation of the electroencephalogram

We owe, for example, to electroencephalography alone the important discovery announced by Gibbs and Lennox in 1939 that carbon dioxide will influence the epileptic seizures Petit rhythm and a seizure may be precipitated by a short period of overventilation by which process carbon dioxide is pumped out and inversely may dramatically disappear while the patient is breathing air containing 3-7 per cent of carbon dioxide

We see now, although this method of ... ... in diseases is only seven years old ... ... contributed enormously to the understanding of the physiological functioning of epilepsy ...

II *Intracranial Lesions*—LOCALISATION OF TUMOURS

The next of the important practical applications of electro-encephalography is the detection and localisation of intracranial lesions The principle, first applied by Walter, is extremely simple Cortical potentials of different regions are recorded by the multichannel recorder which writes simultaneously the electroencephalogram of three to six regions

A tumour or a haematoma does not generate abnormal electrical waves, but if it compresses the neighbouring brain tissue and produces through oedema, partial anoxia or some other condition then a physiological depression appears which gives rise to slow, high voltage electrical waves Appearance of such waves, therefore, points to a lesion The region from which it appears points to its localization Superficial cortical lesions cause the greatest change and, being confined to a relatively restricted area within an inch or so of the electrode, are easily detectable Deep-seated lesions are evidently less easy to localize Practical success is evidenced by the results of electroencephalograms of patients taken by various enthusiasts Dr R S Schwab followed up 417 electroencephalographic localizations made at the Massachusetts general hospital In 115 cases the localization had been clear and definite, and verification by operation or on post-mortem examination exhibited correct localisation within the area of surgical incision in 84 5 per cent of the cases In 89 cases where the electroencephalogram gave doubtful evidence and the best guess possible was made at the surgeon's request, accuracy was only 43 per cent. It is important to note that most of these cases showed abnormality in the posterior fossa Such groups particularly when they caused increased intracranial pressure may be very deceptive for the electroencephalogram In 213 cases no evidence of focal lesion was detected by the electroencephalogram Later, 9 per cent showed a focus on necropsy or in the operation theatre, but 91 per cent never came under the surgeon's knife, though the present hospital diagnosis supports the electroencephalographic report This remarkable degree of success of Schwab is in accordance with the earlier findings of Williams and Gibbs They worked on 105 cases in which intracranial lesions were suspected and found a close correlation between the actual position of the lesion and that predicted by the electroencephalogram Actually 35 out of 50 showed actual lesions at the operation table or on necropsy In another 15 cases clinical evidence was strong and was supported by previous explorations with the help of x-rays and visible changes like skull defect, scalp wound, visible mass, etc In 41 cases, in which no abnormality was predicted by the electroencephalogram, subsequent clinical examinations too gave negative results The remaining 14 cases could not well be judged through lack of data

Schwab seeks to explain the few discrepancies by the following reasons —

(a) Failure to use a sufficient number of electrodes

(b) Bilateral disturbance caused by deep lesions near midline

(c) Counter-coup pressure effects produced by large flat lesions outside the cortex— e g , subdural haematomata

Apparently the method has great practical value as a *diagnostic procedure in routine neurological practice,* but we must not be lifted off solid ground through amateur enthusiasm The electroencephalogram by itself alone is in reality as sure and accurate as roentgenography or neurologic examination, taken alone. It is only a combination, rather a concordance, of any of these 2 that errors in diagnosis could be made negligible. Moreover, the electroencephalogram tells hardly any thing of the nature of the lesion, for what we see is only the reaction of the neighbouring tissues to the mechanical effect of the lesion

OTHER BRAIN LESIONS INTRACRANIAL HAEMORRHAGE—As we have seen electroencephalography has been very useful in the detection of various intracranial lesions, yet it has not been used to any extent in the investigation of cases of head injury Only a few cases are on record concerning the value of electroencephalogram in cases particularly when intracranial hæmorrhage has occurred Prof Rendle Short and Miss Dunster in 1940 published a paper on middle meningeal hæmorrhage in the case of a patient aged 42 upon whom an operation had been performed Balado, Romero and Noiseus in 1939 gave a paper on electroencephalogram in the case of an Italian aged 41 suffering from chronic subdural hæmatoma Jasper, Kershman and Elirdge in 1940 noted some examples of intradural hæmorrhage, both extra- and intra-cerebral The electroencephalographic findings in these cases constitute cumulative evidence of electroencephalography as an aid to the detection and location of traumatic intracranial hæmorrhage

OTHER ORGANIC DISEASES—In other organic diseases of the brain and in mental disorders the usefulness of the electroencephalogram is still limited We usually observe only slight changes in the recorded waves, and then too repeated records have to be made. In the cases in which 'slow' alphas, of about $7\frac{1}{2}$ per second, are noted, we may take it for granted that they indicate pathological changes associated with an impairment of cortical function Unfortunately, investigations done are few and of a limited nature, but we can confidently assert from what is already known that the scope of the electroencephalogram in the diagnosis of these disorders will be greatly increased in the future.

Carbohydrate Metabolism—Hoagland and his associates studid 6 schizophrenics receiving insulin treatment, and made 35 records They found that electrical waves of the brain after large doses of insulin showed a definite slowing in frequency of alpha waves This, with a time lag of about $\frac{1}{2}$ hour, ran parallel with the *decline* blood sugar curve Sugar injection during coma restored the frequency along a smooth curve Along with other evidence we hold that alpha frequencies are directly proportional to the rate of carbohydrate metabolism of the cortical

cells producing the rhythm This discovery has a possible potential application to disorders of carbohydrate metabolism If the alpha waves are directly proportional to the rate of carbohydrate metabolism we should expect to use electroencephalographic index during insulin administration

Brain Waves and Pilots—By far the most thrilling development of the application of electroencephalography to human problems has its use in routine examination of student-pilots

Its importance in the diagnosis of petit mal, which disease is characterised by loss of consciousness for only a second or more with or without minor muscular twitches in the face and the eye, has already been stressed The momentary blackouts and losses of memory which are connected with the undiscovered form of epilepsy are of utmost importance for fliers whose attention must never lessen even for one moment The importance of electroencephalographic investigations to weed out such minor cases which are apt to be overlooked otherwise becomes-apparent

Besides, the susceptible epileptics which do not show any symptom whatsoever may at any time become epileptic with possibly disastrous results And there is no possible method of diagnosing these except with the help of the electroencephalogram

It is with these considerations that, under the direction of Major G E Hall and J É Goodwin, Canada has established a clinical investigation unit of the Royal Canadian Air Force. The United States Navy was so impressed with the results that it has established its own brain-wave clinic at the Naval Training Station at Pensacola, Florida Hallowell Davis and Alexander Forbes of Harvard Medical School, and Hudson Hoagland of Clark University examined the brain waves of some hundred student pilots there

At the Boston City Hospital, under the direction of F A Gibbs, the Work Projects Administration is preparing standards of normal to be used in classifying student fliers Of the two thousands students so far examined about one per cent turned out to be marked epileptics

The brain wave analysis therefore may be of tremendous help in the air service arm

Summary of the Work Done

Since 1924 when Berger first started working on the subject till the appearance of the latest reports in the journals the progress has been two-fold

One is the specific investigation of the *nature* of the encephalogram and another is its *application* to human problems

Regarding the nature we have learnt to distinguish the alpha and the beta waves and attribute sources of each The corpus muscta and superficial some re limb. We have besides discovered that each convolution region has its own independent activation

In the field of *application* of electroencephalogram we have learnt to correctly diagnose the types of epilepsy, particularly the petit mal We can predict the seizures, differentiate the hysterical and symptomatic from the genuine and weed out the susceptibles from a group of apparently healthy people.

We are now approaching a future method of treatment of epilepsy by objective observation of reaction, nearing a greater degree of individualized effective therapy

We have evolved a diagnostic procedure for localization of tumours, now on the verge of being used as a routine measure in hospitals

We have also found a direct proportion between the alpha waves and the carbohydrate metabolism

Last but by far the important development has been the electroencephalographic method of weeding out epileptics from the student pilots, being used extensively in United States and Canada

The Future of/in Electroencephalography

Electroencephalography is the most direct objective indicator of cortical activity now available An electroencephalogram is a true record of what the most complex organ in human body is silently doing The significance of the correct interpretation of this vastly complex record of cortical potential variations should therefore be fully understood. Mere arbitrary classification of the waves into alpha and beta on primary consideration of frequency does not mean more than a preliminary acquaintance with the meaningful language of electroencephalography Our present knowledge about the subject is equivalent to recognition of a few letters We have yet to learn to spell the words—correctly, understand their meaning, corelate them into sentences and thus master the great language

We do not undervalue the extensive work done on the subject We maintain, however, that the medical world has been too jubilant over the discovery of a direct method of investigating the crude lesions and maladies of brain The excitement about the introduction of this method has been such that the most important issue has been side-tracked That is the investigation *into* the nature of electroencephalogram The medical world has been enthusiastic to apply the little they know about the "great method", but not, as yet, to human problems The utilitarian aspect of the subject does no doubt equally deserve our attention, but not all of it

In our opinion special investigations should be carried to investigate fully and interpret completely the electroencephalogram and relevant work and in future should be carefully corelated to that end

A development of encephalogram of brain will certainly give us the correct knowledge about the organizing in the higher centers

related to the psychic cortex It has been further found that an increased activity of beta waves is accompanied by a diminution of alpha waves We know that higher psychic centres have an inhibitory control over the lower centres If the beta waves show a similar control the parallelism should lead us to conclude that waves with greater frequencies belong to the higher psychic centres, those with the slower ones to the lower The existence of faster beta waves should therefore mean more developed higher psychical centres

The electroencephalograms of the babies should decide the issue. If they demonstrate a preponderance of slow alpha waves this hypothesis should be taken as correct, as the higher psychical areas develop later

Besides working with the electroencephalogram of the babies we may be able to note the electroencephalographic reaction to the external stimuli The electroencephalogram of a new born baby may be regarded as a 'pure electroencephalogram' We may be able to clearly distinguish any superimposed wave on the original characteristic as indicative of an auditory-word memory centre activity This is only an example What is meant, in short, is that we may start with a pure basic electroencephalogram of a new born baby and study it as it grows correlating its mental acquirements by resultant electroencephalographic changes if any

Through large scale work we believe it would be possible to correlate many mental conditions with characteristic encephalographic records

During investigations of electroencephalograms of the student pilots in America, it may be recalled, an effort was made to pick out from their brain-wave records men who will make the best pilots Although conclusions are not yet forthcoming the reports are that evidence is mounting that men with persistent alpha waves in the frontal region of the brain do not make good pilots We see thus a correlation of characteristic electroencephalographic complex a definite mental capability, say the capability of continuous concentration If therefore we could recognize waves corresponding with and characteristic of capability of concentration we could similarly correlate other wave-complexes with their respective psychic counterpart, memory, genius and stability of character etc

This at once opens up the great possibility of a direct objective study of personality components By an extensive investigation into them we could be able to compose a dictionary of personality-components—a breath-taking advance in Psychology! And yet what could be more reasonable than correlate the true records of cortical activity with their psychic counterpart. If the behaviour of an individual is the end result of cortical activity, which it undoubtedly is, we are bound to find the counterpart of every cortical activity in a properly recorded electroencephlogram

The electroencephalogram should therefore be a basis of experimental psychology

The electroencephalogram of each individual has its own style just as one has his own style of hand-writing It is reported that it changes little with age once it has reached adulthood. In some persons, reports a recent article, the voltage is a little higher, in some the alpha rhythm a little faster or slower or little less regular and in others there is a little less of alpha activity and more of smaller faster words "These types of electroencephalorgaphic patterns, therefore, apparently represent constitutional differences and there is an increasing body of evidence that certain aspects of habitual behaviour or 'personality' may correlate with extremes of pattern" The workers on epilepsy have reported that many varieties of electrical pattern and many gradations of odd and unusual behaviour are seen, and the clear diagnostic electrical patterns and definite clinical manifestations of clear-cut types merge gradually into what are called "generally dysrhythmic electroencephalograms" and "behaviour problem" individuals -A high incidence of dysrhythmic electroencephalogram in problem children has also been reported

A further study on this problem should, therefore, be justly demanded and we will not be surprised if an application of electroencephalogram to criminal investigation and reformatory schools of the juvenile criminals is forthcoming as a result

An application of this to other aspects of psychology could also be imagined. We could explain likes and dislikes of individuals We could seek to explain the liking of an individual for another on the basis of sympathetically vibrating electroencephalograms It is not a fantastic idea, as identical twins always have closely similar patterns of the same type Love, if it has any basis besides sex may happen to depend a great deal on a similarity of brain waves The electroencephalograms of two individuals who have a strong liking for each other may not show much similarity in adulthood We may suggest, however, that the similarity may be in the 'basic' waves of early childhood and not in the later superimpositions which are a result of environments

With a few facts here and there in accordance with our views on the future of/in electroencephalography, we may say with some degree of confidence that electroencephalography has in store for us great developments in experimental psychology and treatment of diseases of the brain.

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CASE NOTE

PLASMODIUM OVALE INFECTION IN U P
An Interesting Case of Malaria

N TYAGI, CAPT I A M C,
Officer I/C Station Laboratory

The case is by no means unique, but in view of the very mild nature of the attack, spontaneous clinical and parasitological cure, oval shape and enlarged size of the infected erythrocytes, preponderance of Schuffner's dots and the presence of various unusual and paradoxical forms of parasite, it certainly becomes a really interesting case.

CASE REPORT

H A K, a Mohammedan male, aged 24, was admitted complaining of fever with rigor the previous night

He had normal temperature for two days in the hospital On the third day afternoon, his temperature suddenly shot up to 103° F with rigor Blood smears were found positive for malaria, but antimalarial treatment was not instituted as some uncommon forms were seen in the smears No previous history of malaria was available Next day the smears were re-examined, the abnormal forms were confirmed and a supply of two hourly blood smears requested

It would be seen from the temperature chart that the patient ran a very mild course of the disease and that the clinical recovery occurred long before the antimalaria drugs were administered on the 11th day

The figures show camera-lucida drawings of some of the parasites seen in thin blood smears, which were stained by Leishman's stain for five minutes Attempts have been made to make them as representative as possible The table gives the description of the average characteristics of the parasites seen

COMMENTS

The following special characters of the case may be noted

(i) *Temperature chart*—The chart shows that the patient ran a very mild course of fever and that
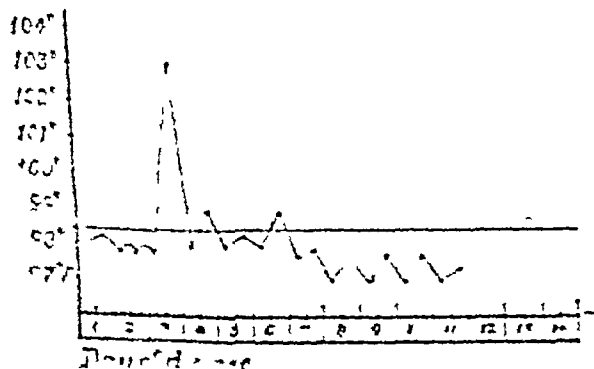
Temperature Chart of the Relapse Case

the clinical and parasitological recovery occurred some days before the anti-malaria treatment was instituted on the eleventh day

A mild attack with spontaneous recovery is said to be the characteristic of *P ovale*, but it is by no means uncommon in relapse cases of *P vivax* and *P malaria* J G Thomson, in *Trans Roy Soc Trop Med & Hyg* Vol XXVI, pp 483-514, has shown that after spontaneous recovery from benign tertian malaria an immunity to superinfection develops, which is, however, specific in character Although an exact proof of the presence of immune bodies in the system is still lacking, there is no doubt that the so-called 'tolerance', 'premunition' or 'relative immunity' does develop as the result of previous infection—but in the case, under review, there was no history of previous attacks of malaria In addition, heredity or racial immunity may play a part too, but that too does not seem to be applicable in this case

(ii) *Rigor was in the evenings*—Fairley, Muhlens and others (Manson's Tropical Diseases, 1945, pp 843) state that the paroxysms of fever due to *P ovale* infection come on in the evening or at night. This discrimination, however, is rather misleading since it has been observed that certain typical cases of *P vivax*, *P malaria* or/and of *P falciparum* infection are associated with attacks beginning in the night or early in the afternoon

(iii) *A large number of the infected erythrocytes were oval, slightly enlarged and showed Schuffner's dots*—In *P ovale* cases the infected cells are said to be oval, but generally not much enlarged, while in *P vivax* infection the reverse is the case Schuffner's dots seen in both the types of infection were also found in the case—these could not be confused with Ziemann's stippling, which are characteristic of *P malaria* infection and take much longer time to be stained by the Leishman stain Diagrams show that a large proportion of the infected cells are oval, though the margins are not typically fimbriated

(iv) *Some atypical and confusing forms of parasites seen* *

(a) *Band forms*—(specimen 43 : dr Plate) In *P ovale* although the parasites more nearly resemble *P malaria* band and ribbon forms so characteristic of the latter are generally held to be absent Manson Bahr in his book on Tropical Diseases states that in *P ovale* cases parasites give an appearance which in all the stages of its growth resembles *P malaria* but differ from it by the absence of band forms Band like forms are NOT seen in *P vivax* or/and *P falciparum* infection

(b) *Terminal forms*—(specimens 29 & 35 : de Plate) are suggestive of *P ovale* infection Schuffner described *P ovale* a form of malaria which was described as recently by him as a separate World Species and has since been confirmed

TABLE—SHOWING THE COMMON CHARACTERISTICS OF THE PARASITES

Day of Disease	Smear taken at	Hours after first rigor in hospital	Specimen number	Size & shape of infected erythrocytes	Pigment	Characters of the trophozoites	Schizonts	Gametocytes	No of parasites per field
3rd	4 P.M	0	1-10	Slightly enlarged and generally oval Schuffners' dots well marked.	Nil	Large vacuolated and solid forms occupying a major portion of the cells Chromatin well marked Accole forms not seen.	Nil	Nil	1-2
4th	2 P.M.	22	11-18	Slightly enlarged some oval, and paler in colour Schuffner's dots not marked	Coarse brown in some.	Tendency to assume tenuae forms Cytoplasm detached, chromatin well marked, and in some even divided	Nil	Nil	1 or less
"	4 P M	24	19-28	Enlarged Schuffner's dots present	Well marked, some brownish black	Band forms frequently seen Chromatin marked.	No typical ones seen	Nil	1 per 3-4
"	6 P M	26	29-36	Less enlarged and mostly oval Schuffner's dots scarce, and paler in colour	Scarce	Tendency to tenuae forms, chromatin well marked.	Nil	Nil	1 or less per 3
4-5th / 5th / "	8 P M / 10 P M / 12 Midnight / 4 A.M / 6 A.M	28 / 30 / 32 / 36 / 38	37-42	Slightly enlarged, many oval, Schuffner's dots variable	Coarse, brown	Band, solid forms and some wide rings seen Detached masses of cytoplasm frequently seen Chromatin prominent and divided in some	No typical ones detected.	Doubtful None typical seen	1 per 3-4
"	10 A M	42	43-51	Somewhat enlarged, some oval Schuffner's dots marked in most.	Coarse brown, tendency to aggregation	Some band forms Division of chromatin frequently seen	Earlier forms seen Merozoites six or less	Doubtful and scarce.	1 per 5-6
"	12 noon	44	52-58	Enlarged, some oval Schuffner's dots fewer present.	Mostly aggregated, dark brown.	Division of chromatin, with masses of cytoplasm	Present with more than six merozoites	Very scarce	Hardly 1 per 10
" / " / 6th / "	2 P M / 6 P M / 10 P M / 2 A M / 8 A M	46 / 50 / 54 / 58 / 64		The characteristics of the parasites were similar to those described above (Specimens 52-58) but their number per field gradually diminished so much so that in certain films not more than two or three were detected after prolonged and thorough search					

N B—No parasites detected in smears taken on the 8th day of disease at 12 A M and 4 P M, on the 9th day at 2 P M and 6 P M and on the 10th day at 3 P M and 7 P M. Antimalaria treatment started on the 11th day of disease at 8 A M

in India in 1914 Sinton was inclined to support his contention that it was a separate species, while Belfour and Wenyon considered tennue forms to be not uncommon in *P falciparum* infection On the other hand, Chamars and Archibald described a tennue phase of *P vivax*, stating that altered forms of parasites are not uncommon in cases with spontaneous recovery as a result of the development of some complex protective mechanism

In the case under review, there appears to be a tendency to spontaneous recovery, and, therefore, somewhat small forms of parasites may well have been brought about by the degenerative process due to the action of body protective mechanism—this sounds highly theoretical in the absence of previous attacks of malaria

(c) *Schizonts with more than six merozoites not seen*—This is characteristic of *P malaria*, and is also a common feature of *P ovale*, which resembles the former in many ways

It is, however, true that often in typical *P vivax* cases most of the schizonts seen in the blood films do not show more than 6-8 merozoites for the simple reason that these are really early schizonts—typical and mature ones being rarer to see In this case, never-the-less, not even one was seen to contain more than six merozoites despite prolonged and very careful search of the blood films, especially that taken 44 hours after the rigor

DISCUSSION

It would appear that the case cannot be one of *P falciparum* or that of *P tennue*, since in these infections the largest forms of the parasites seen in the peripheral blood are held not to exceed half the diameter of the infected erythrocyte This fact is not borne out by the blood smears of the case Besides, the presence of enlarged r b c s and that of the marked Schuffner s dots are also against these infections

Band forms suggest *P malaria* infection, but the enlargement of erythrocytes and the presence of Schuffner's dots rule that out These dots could not possibly be Ziemann's stippling as the Romanovsky stain was not left on the slide for more than five minutes

The possibility of its being a mixed infection of *P vivax* and *P malaria* are rather remote for the reasons that (a) such an infection is very rare and (b) if it were a fresh double infection there should have

been many more paroxysms of fever, and if it were a relapse it looks highly improbable that the two infections would appear and disappear simultaneously

It, therefore, now remains a case of benign malaria either an infection of *P vivax* or that of *P ovale*

Enlargement of erythrocytes, presence of Schuffner's dots and the presence of many stages of the parasite in the same blood smear are pathognomonic of *P vivax*, but the presence of band forms, and the fact that none of the schizonts, in any of the smears taken at different times, shewed more than 6 (six) merozoites are paradoxical

The presence of oval infected erythrocytes, dark brown pigment as against the pale brown of *P vivax*, early division of chromatin, evening rise of temperature and the spontaneous cure (both clinical and parasitological) are the points which can not be overlooked, and the diagnosis of malaria *P ovale* should not be lightly brushed aside on the flimsy basis that such an infection has not previously been reported in the station

SUMMARY

A case of malaria *P ovale* is described

Camera lucida pictures of the infected erythrocytes have been reproduced Attempts have been made to draw the diagrams of the specimens as actual as possible in colour and size as seen under 1/12″ oil immersion lens

Unusual findings have been discussed, in relation to various possible diagnoses

CONCLUSION

From the discussion it is apparent that the balance of evidence is strongly in favour of the case being one of *P ovale* infection, although by no means a typical one.

It is very much regretted that the slides could not be produced before the experts now This case was noted some years back and because of the peculiarity of the cases the slides were sent overseas with the article The personal opinion of experts differed but the consensus of opinion seemed to favour the diagno is given herein It was to the author's greatest regret that slides were lost in transit during the war conditions He is however, extremely grateful to the authorit for having conceded to publish it and I must naturally take the responsibility for the correctness of the statements

THE PROBLEM OF HUMAN STERILITY

By far the largest majority of cases in gynæcological practice is centered round conception and childbirth Some of them want babies and cannot have them Some have had enough and want no more while others seek relief from conditions which are the outcome of childbirth From the records of three large hospitals in India it appears that a little over 10 per cent of hospital admissions are for the treatment of sterility But when is a woman to be considered sterile? Matthew Duncan put it to three years after marriage But modern civilisation and social consciousness of young men and women often complicates this definition The question of voluntary contraception comes in Statistics from maternity hospitals show that the largest number of primiparous confinements take place within three years of marriage But hospitals receive patients from all classes The figures obtained from four private nursing homes in one of the largest cities in India however indicate that no less than 70 per cent of primiparous confinements take place five years or more after marriage It would thus be better to consider each case of sterility on its own merit considering among other things the personal history of the couple

Only about twenty years ago investigation of a case of sterility consisted in the discovery of a congenital abnormality, tented vagina, pinhole os, cochleate or fibroid uterus, tubo-ovarian mass or some other gross abnormality If these were absent, and the fallopian tubes were patent, dilatation and currettage and "hard prayer" were all that was advised as treatment In the times that have gone by, we have known more about the physiology of conception, though this knowledge has been yet far from complete Indeed, the process is so complex that one should wonder as Bourne[1] suggests, at the frequency of successful conception rather than at its occasional failure

When obvious pathological lesions are present a case seldom presents an obstacle But when it is not so, the condition of so called functional sterility, frequently defies elaborate investigations This holds good even in the case of the male partner Sperm cell count has been known to be important for a long time The recent interesting experiment of Chang[2] shows fairly conclusively the effect of sperm cell concentration on the fertilising capacity of the semen This author inseminated 20 doe rabbits with known

number of spermatozoa in different dilution, and studied the number of cleaved ova obtained He observed that 17 to 42 per cent, 0 to 28 per cent and 0 to 6 per cent of the ova were cleaved when a similar number of spermatozoa (30,000-44,000) were suspended in 0 1, 0 4, and 1 c c. of saline He also observed that the maximum of only 19 per cent cleaved ova were obtained when the number of spermatozoa were doubled (80,000) but suspended in 1 c.c of saline It thus appears that what is important is not merely the number of sperm cells in the seminal fluid, but the concentration of it Nevertheless, mere number and concentration are not the only things that matter Dead sperms do not fertilise, nor do the abnormally formed ones Douglas[3] in an investigation found that when abnormal forms made up 25 per cent of the total, sterility was the usual rule Viability of the spermatozoa is another important factor The application of this in another form is in Huhner's test which is quite widely employed in most sterility clinics Viability and motility have however been shown in recent years to depend on the normal metabolism of the semen Mann[4] demonstrated that for metabolism of the spermatozoa in anaerobic conditions, as happens normally after insemination, fructose must be an essential constituent of the semen (glucose can also be similarly utilised but fructose is better) Fructose is added to the seminal fluid by the vesicles and the prostate This enters into combination with adenosine triphosphate present in the sperm cells and passes through a chain of reactions to lactic acid Ivanof, Kassafina and Fomenko[5] also showed that under these conditions adenosine triphosphate decreases, and with it also the motility of the sperm cells, which is restored on the addition of glucose The first two authors (loc cit) also showed that the activity of the sperm cells could be increased markedly, adding prostatic secretion to the spermatozoa These recent investigations demonstrate that the functional activity of the spermatozoa depend not merely on the number and formation, but also on the function of what have been known heretofore as accessory organs of generation Thus investigation of the husband also includes a careful inquiry into the physiological activity of the prostate and seminal vesicles The normal content of fructose in the semen has not yet been definitely known, much less how it can be increased The same holds good for the adenosine triphosphate content of the sperms But when these are known one more avenue for our knowledge in the subject will be opened

Recent years have also told us about another important role played by the sperms in the physiology of fertilisation This is the dispersal of corona radiata cells by the enzyme hyaluroniease normally present in the spermatozoa This enzyme causes the liquefaction of the gel which cements together the cells surrounding the ovary, thereby bringing the spermatozoa in close contact with the membrane of the ovum itself

[1] Recent Advances in Obstetrics and Gynaecology, 1939
[2] Science, 104 361, 1946
[3] Urol Cut Rev—1 529, 1946
[4] Biochem J, 40 481, 1946
[5] Nature—158 624, 1946
[6] Am J Med, 1 491, 1946

Kurzok, Leonard and Conard[6], who demonstrated this property of the semen also reported six cases of sterility where application of hyaluroniease to the cervix produced conception The evidences are certainly not conclusive, but undoubtedly opens a greater vista Leonard, Perlman and Kurzok[7] also devised a means of estimating the hyaluroniease content of the semen which is worthy of trial in every equipped laboratory in sterility clinics Kurzok and others (*loc cit*) found that the enzyme content may have a relationship with the sperm count of the semen, 50 million being about the critical point It has of course been known for a long time that below this level the fertility index in men is low

Recent years have shown that functional disorders in the female with regard to sterility are principally centered round the behaviour of the ovary and cervix Ovulation is the primary essential to fertilisation Menstruation is no longer a certain sequela of ovulation Anovular menstruation is no more a hypothetical entity Anovulatory cycles may be found even in normal individuals Levan and Szanto[8] found the incidence of anovulatory cycles as 8 7 per cent Approximately about 9 per cent of women have anovulatory cycles while among sterile subjects the incidence increases to about 30 per cent (Bourne, *loc cit*)

The estimation of ovulation has then in present years become a subject of considerable magnitude The simplest means is undoubtedly endometrial biopsy and discovery of secretory change For all practical purposes this is a simple and reliable method Samuel's[7] spectroreductometric method demands skill and experience Determination of walking temperature curves is simple and costs nothing An intelligent patient can willingly co-operate to keep this chart We have found this a reliable index of ovulation as verified by endometrial biopsy The time of ovulation on a W T chart should be read at the lowest point of the ebb

Determination of mere presence or absence of ovulation is naturally not enough Ovulation taking place within two days of menstruation produces the same effect as anovulation, as fertilisation must occur at least 48 hours before menstruation for embedding of the zygote to take place History of coitus in relation to the time of ovulation is another important investigation, a point which is not unoften neglected

Fertilising capacity of the spermatozoa does not probably last for more than two days after insemination The viability of the ovum also is probably not more than 24 hours after ovulation and certainly not more than 48 hours If fertilisation does not occur during the period of viability the ovum becomes surrounded by a dense albuminous envelop which is unimpregnable by sperm cells

The behaviour and function of the cervix has been known in recent years and is most interesting This explains many of those cases which used to pass in older days as "incompatibility" between male and female partners As early as 1933, Seguy and Vimeux[9] suggested the existence of a chemolactic affinity of the cervical mucus towards the sperm cells With "compatible" cervical secretion progressive and steady invasion of the mucus plug by sperm cells is the rule In "incompatible" cases this invasion is retarded and sometimes completely prevented So far the matter is simple enough to understand, but the story does not end there The nature and quantity of the cervical mucus is not constant through the menstrual cycles During each ovulation the cervical secretion becomes more abundant and altered in consistency These rheologic properties have been the subject of considerable discussion in the present times Clift[10] in a masterly study of the subject drew attention to two properties of the cervical mucus, *viz*, flow-elasticity, and capacity of the fluid to be drawn into threads (spinnberkeit) A menstroscope can be used to measure the flow-elasticity of the cervical mucus Spinnberkeit can be measured equally easily by drawing away a coverslip placed on a drop of mucus and measuring the thread produced in centimeters Both these functions of the cervical mucus are more pronounced during ovulation and insemination when these functions are at their highest is most conducive to the occurrence of conception

This is a part of the story of the human inquisitiveness in unmasking one of the well kept secrets of nature Sterility in olden days was a simple subject which called for a more or less straightforward line of treatment With the increase of human wisdom the complexities in this most primitive physiological process are gradually being revealed We do not know all yet, but with the little knowledge we possess now, one will be right in calling human sterility a problem The solution of which is still further than we wish it to be Yet how very simple are processes of Nature is in all those cases, where it succeeds

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' Am J Obst & Gyn 48 75, 1944.

'Gyn et Obst 27 56 1933
"Proc Roy Soc Med 39 1 1945

ON EXAMINATION.—The child was very ill. The temperature was 102° and the pulse-rate 130 per minute. The whole of the right arm (shoulder to elbow) was glassy, swollen, and exquisitely tender. Although the swelling involved both the shoulder and elbow regions, the impression was formed that the inflammatory process was confined to the humerus. There was no evidence of pyæmic dissemination.

OPERATION.—Under open ether anæsthesia the right humerus was exposed by the incision as already described. The incision opened the periosteum and was carried at least an inch higher up the bone than the circumflex vessels, which were divided. Subperiosteal collections of pus were evacuated from almost the entire length of the humeral shaft. The exposed antero-lateral aspect of the bone was freely removed, pus liberated from the medulla, and the wound

FIGS. 14. 15.—Functional results eighteen months after original operation.

FIG. 16.—Skiagram of humerus eighteen months after original operation.

lightly packed. The child was critically ill for the next twenty-four hours, but after that soon commenced to improve.

During the next year several operations were performed—some for the removal of sequestra, whilst others were manipulations aimed at the restoration of joint movements. The wound finally healed in November, 1927.

Eighteen months after the original operation the child was examined and found to be in good health. At the shoulder-joint there was a normal range of movements. Extension at the elbow-joint was somewhat limited, but

flexion, supination, and pronation were good. *Figs.* 14, 15 illustrate the arm movements that were possible ; the skiagram (*Fig.* 16) reveals the late condition of the bone. The division of the deltoid having been carried upwards for rather more than an inch above the level of the circumflex vessels, it is interesting to note that both portions of the deltoid (i.e., those on either side of the scar) reacted in an exactly similar manner to electrical stimulation.

My thanks are due to Professor R. Bramble Green and Dr. James Whillis, of the University of Durham College of Medicine, for their kind and generous provision of anatomical material and advice. Mr. Sewell's drawings are so clear that a written description is almost superfluous. Finally, there must be acknowledged the willing help and stimulating criticism which I have received from Professor G. Grey Turner.

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DEVELOPMENTAL ENTEROGENOUS CYSTS AND DIVERTICULA.

(Based on a Hunterian Lecture delivered at the Royal College of Surgeons of England on Jan. 28, 1929.)

By ARTHUR EVANS,

SURGEON TO THE WESTMINSTER HOSPITAL, LONDON.

CASE REPORT.

A MALE, age 29, was admitted on Oct. 17, 1925, into Westminster Hospital complaining of ' pain in the lower part of the abdomen '.

In April, 1923, the patient first experienced his attacks of pain, which occurred at intervals of about three hours, for a period of seven days. Each attack consisted of griping pain over the whole lower abdomen lasting for about fifteen seconds ; this was occasionally followed by pain in the epigastrium, lasting for a shorter period. The griping pain was severe and ' doubled him up '. The patient kept at his work during the whole of the week. The pain bore no relation to the ingestion of food or to exertion. During this week there was loss of appetite and malaise. There was no constipation or diarrhœa. The patient has always had a daily action of the bowels without taking drugs. A similar bout of these attacks occurred later in 1923, another in 1924.

In September, 1924, whilst lying in bed he experienced a strange sensation (described as ' heaviness ') in the right side of the abdomen, and on examining the site found a ' lump ' there. This lump has appeared many times since ; it stays for a minute or less, then passes away—occasionally with a slight gurgle. If rubbed the swelling disappears at once ; it is painless, and its presence seems to have no relation to the occurrence of pain.

In February, 1925, there was another series of painful attacks, occurring at intervals of about two hours. These were repeated in June and September. The patient was seen in the out-patient department and admitted into the wards with a diagnosis of tumour in the right side of the abdomen.

When I first examined the man I could detect nothing abnormal in the abdomen other than an easily palpable cæcum, and I wondered at the previous diagnosis. I saw the patient the following day and again could detect only this palpable cæcum ; but as I watched the abdomen an obvious tumour developed in the line of the ascending colon. The anterior abdominal wall bulged forward over a circular area about four inches in diameter, the centre of which was raised about one inch above the level of the surrounding abdominal wall. On palpating this a tumour about the size of a cricket ball could be felt ; in a few seconds the tumour softened and faded away. There was no doubt then that the ' lump ' was a piece of gut, either the distended cæcum or a portion of the ascending colon.

Operation.—On opening the abdomen, the cæcum was seen to be larger than normal. About the middle of the ascending colon a strong, wide,

vascular band of adhesions was found extending from the outer to the inner border of the colon, somewhat constricting the gut. I divided this, along the line of the anterior tænia coli, and the constricted portion of the gut distended to the size of the neighbouring colon.

The vermiform appendix was, save for the terminal inch, adherent to the posterior surface of the cæcum, and was removed. On palpating the cæcum a cystic swelling could be felt in its interior; this was continuous below with the wall of the cæcum, but its upper end was free in the lumen of the gut. On opening the cæcum the condition shown in *Fig.* 17 was discovered. The cystic swelling was covered by the mucosa lining the gut. I endeavoured to enucleate the cyst through an incision made through the outer coats of the cæcum at its lowest extremity, but failed; the wall of the cyst was continuous with the muscular wall of the cæcum. In this attempt I opened into the cyst, and a milky mucoid fluid escaped. The cæcum and adjoining ileum were then excised and an anastomosis made between the end of the ileum and the side of the ascending colon.

The interior of the cyst was at once packed tightly with wool and the whole specimen placed in dilute formalin. As a result of this the cyst did not share in the general shrinkage process, and now presents the appearance of being partly extracæcal.

Fig. 17.—Developmental enterogenous cyst of the cæcum. The ascending colon and cæcum are laid open by a vertical section, the cyst being thus exposed. No part of the cyst is really extracæcal. A, Ascending colon; B, The site from which the section shown in *Fig.* 18 was taken; C, Intracæcal part of cyst; D, Ileocæcal junction; E, Ileum; F, Intramural part of cyst; G, Anterior tænia; H, Right tænia. (×⅗.) (*See* Lotheissen's case, p. 64 and *Fig.* 47.)
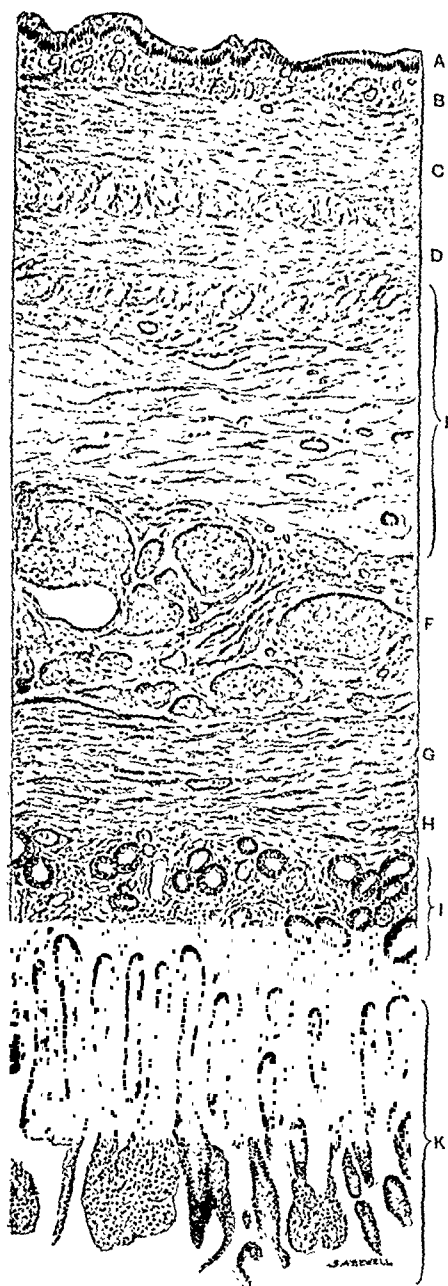
This, however, is only apparent; the cyst is almost entirely intracæcal and partly intramural. The recovery was uninterrupted.

REPORT ON A SPECIMEN OF CYST OF THE CÆCUM.

By Sir Arthur Keith.

The relations and characters of this cyst are shown very clearly by Mr. Sewell's drawing (*Fig.* 17), which represents the specimen as now mounted in the Museum of the Royal College of Surgeons.

The cyst is a large sausage-shaped structure, one part lying within the cæcum, the other extruding from the fundus of that organ. These two parts —extracæcal and intracæcal—are of about equal size. The total length of the cyst in its state as now exhibited is 14·2 cm. long, with a diameter of 5 cm. in its extracæcal part and 4 cm. in its intracæcal. Although part of the cyst is described as extracæcal, this is true of the appearance rather than of the reality.

The nature of the cyst, which is certainly developmental in origin, is brought out by the study of a section of its wall such as that represented in *Fig.* 18. The site of this section is indicated in *Fig.* 17 at the highest point of the intracæcal part of the cyst. The section shows that walls of both cyst and cæcum are included.

The cyst is lined by a stratified epithelium 30 μ thick, the basal layer of the cells being columnar, while the upper stratum—two or three cells in depth— shows elements which are cubical, flattened, or transitional in shape. Nowhere does the epithelium form glandular crypts, and yet in my opinion it must be regarded as representing the lining membrane of the alimentary canal. The distension of the cyst has probably led to flattening and atrophy of its epithelial lining.

The section shows, next to the epithelial lining, a dense submucous layer, only 40 μ in thickness; then comes a double coat of musculature, made up of circular and then longitudinal elements, the total muscular stratum being 400 μ thick. In most parts there are but two muscular layers, an inner circular and an outer longitudinal, but at certain points there are as many as four alternating layers. Outside the muscular coat of the cyst proper comes a stratum of loose fibrous tissue. Then come two muscular coats, a longitudinal and a circular, clearly representing the muscular coats of the cæcum. the fibrous tissue—between the muscular

coats of the cæcum and cyst—corresponding to the fused subperitoneal tissues of both structures. The combined muscular coats of the cæcum measure 700 μ in thickness, but in neither the cæcal nor the cystic musculature can the myenteric (Auerbach's) plexus be traced.

Then follow the submucous coat of the cæcal series (300 μ in thickness), and lastly the mucous coat, which is 900 μ in depth, being made up of elongated closely set tubular glands—glands of Lieberkühn. The muscularis mucosæ is very imperfectly separated, the reason of this being seen in *Fig.* 18. There it will be seen that at the bases of the tubular glands and the site of the muscularis mucosæ there occur coiled ducts laid open in circular and oval sections. There can be no doubt, I think, that these glandular structures represent the coiled ends of glands of Lieberkühn, but they do not occur as a continuous stratum, being absent in some parts. A section of a normal part of the cæcum shows a mucous membrane only 500 μ in thickness, against 900 μ over the cyst wall, while the muscular coat over a normal part of the cæcum has the same thickness as seen in this section. The section first examined reveals a double wall, one pertaining to cyst, the other to cæcum, and shows that the same strata are represented in each.

When a section of the extracæcal part (*Fig.* 17) of the cyst is examined the same strata are encountered as have been enumerated in the intracæcal part of the cyst wall—namely, a lining of transitional epithelium, a thin submucous layer, then a double muscular coat, and lastly one which represents peritoneum and subperitoneal tissue.

In *Fig.* 17 it is shown that the cyst is situated immediately behind the ileocæcal orifice; there the walls of cyst and cæcum fuse. The mucous lining of the cæcum is reflected on the intracæcal part of the cyst at a level which lies slightly below that of the ileocæcal orifice.

At first sight it looks as if the congenital cyst which occurs in the mesentery of the ileocolic angle, of which there is an excellent example in the R.C.S. Museum, No. 1220.01, and the cyst here described, could not be members of the same series. In both kinds the construction of the cyst wall is exactly the same; both represent developmental diverticula of the fœtal alimentary canal, the original opening into the canal becoming obliterated. A study of published cases brings to light forms which are transitional in position between the intramesenteric and the intracæcal forms. I therefore conclude that in the present case the cyst found within the cæcum is a variant of the more usual intramesenteric or ileocolic form.

Why the ileocolic angle should be the usual site at which congenital cysts occur we can give no satisfactory explanation. In no animal do we find any normal diverticular or glandular outgrowth formed at the ileocæcal junction, save the cæcal diverticulum, which in birds is double. There is no reason for regarding ileocæcal cysts as the representative of one half of a bifid cæcum.

ORIGIN.

There can be no doubt that cysts whose walls reproduce completely or incompletely the structure of gut, whether discovered in the wall of the gut, attached to the gut, or even more or less remote from the gut, must have

been derived from the gut. They are enterogenous cysts, and they originated as diverticula in the manner described by Keibel[1] and by Lewis and Thyng.[2] They are developmental enterogenous cysts.

Lewis[3] thus describes the formation of diverticula in the jejunum and ileum : The epithelium contains scattered vacuoles which develop in a characteristic manner. The vacuoles are first indicated by a concentric arrangement of the basal nuclei, and in this stage they have been described as 'buds' or 'pearls'. In the centre of such a bud a small cavity can often be detected (*Fig.* 19 *A*). In later stages the cavity communicates with the intestinal lumen, and the bud forms a knob-like basal projection (*Fig.* 19 *B*). These projections often have a somewhat constricted neck, and the overhanging portion may become asymmetrical, extending aborally along the intestine.
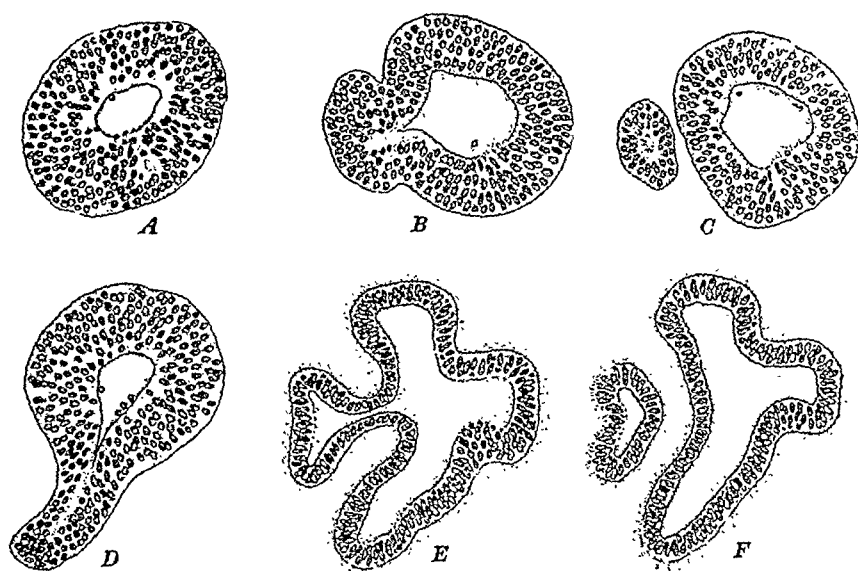
FIG. 19.—Cross-sections of the epithelial tube of the intestine, showing the development of diverticula. *A* to *D* from a 22·8-mm. embryo. *E* and *F* from a 30-mm. embryo. (× 130.) (*From Keibel and Mall*, ii, 384.)

Thus *Fig.* 19 *C* is an aboral section of the diverticulum shown in *Fig.* 19 *B*. Four of the thirty-two diverticula in a 22·8-mm. embryo project aborally. One diverticulum, longer than any of the others, extends laterally so that its tip penetrates the dense mesenchyma of the muscularis (*Fig.* 19 *D*).

Usually they are in close relation with the epithelial layer, and they cause no disturbance in the course of the muscular fibres. In older embryos (*Fig.* 19 *E* and *F*) the folded appearance of the epithelium renders the detection of the diverticula more difficult. It is probable that, by the enlargement of their necks, some of them are incorporated in the general epithelial layer. Others, however, retain their identity.

Summing up their examination of 24 pig embryos, Lewis and Thyng state that in pig embryos from 5·5 mm. to 14 mm. in length, one or two knob-like diverticula occur regularly in the duodenal region (*Fig.* 20). In embryos from 14 to 24 mm. the number of diverticula increases, and they are

distributed along the small intestine. None was found in the large intestine, except in the 32-mm. specimen, where a cluster of diverticula occurred near the ileum. The diverticula appear first in the duodenum and later in the lower portion of the small intestine. They begin as round knobs which may become elongated and detached from the intestine in the form of nodules, strands, or cysts. In later stages they acquire a lumen, and those found in the distal part of the small intestine appear as flask-shaped gland-like pockets. The rabbit embryos which were examined indicated that the diverticula begin to develop at 12 days. A 5-mm. rabbit of 12 days examined showed a pearl-like disturbance of the epithelial cells, suggestive of the later pockets. In a 7·5-mm. embryo of 13 days there was a round pocket with a lumen emptying into the intestine just beyond the duct of the dorsal pancreas. In this embryo there were also three pearls along the anterior limb of the intestinal loop. In a 14-day embryo there was a duodenal pocket near which was a detached epithelial nodule, containing a lumen. There were also four pearls along the anterior limb of the intestinal loop.

FIG. 20.—A reconstruction from a pig embryo of 5·5 mm., in which it is seen that the intestinal epithelium presents a knob just below the dorsal pancreas. A section through this is shown in *Fig.* 21 A. A, Vesica fellea ; B, Stomach ; C, Pancreas dorsale ; D, Diverticulum ; E, Pancreas ventrale. (*After Lewis and Thyng,* ' American Journal of Anatomy ', 1907–08, vii.)

A pig embryo of 17 mm. showed nine diverticula, most of which had a lumen communicating with that of the intestine. They began below the pancreas and were distributed along the duodenal region and anterior limb
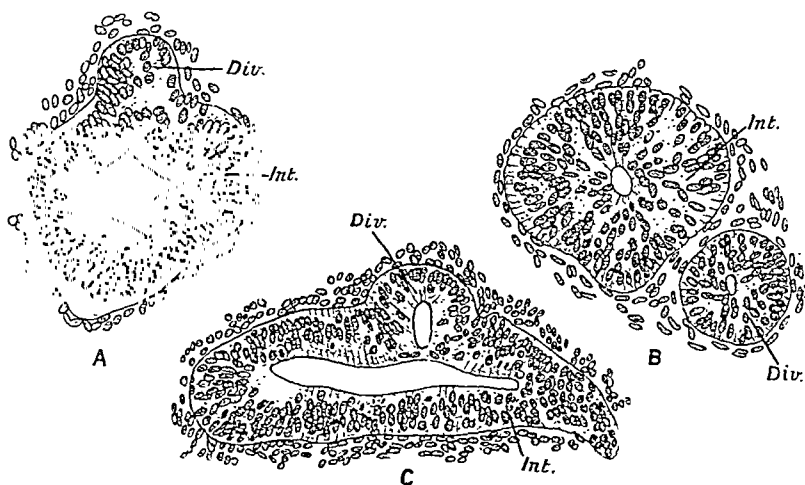
FIG. 21.—A, Section through the intestine (*Int.*) and diverticulum (*Div.*) in a pig embryo of 5·5 mm. (× 150.) B, Similar section from a human embryo of 13·6 mm. In adjacent sections the diverticulum was shown connected with the intestine. (× 150.) C, Similar section from a rabbit embryo of 11 mm. (14 days). (× 100.) (*After Lewis and Thyng,* 'American Journal of Anatomy ', 1907–08, vii.)

of the intestinal loop. Another had ten diverticula and one detached nodule. At 16½ days (18·8 mm.) there were six pockets, each with a lumen. The largest was in the duodenum, and others in the coiled part of the small intestine, separated from the first by a considerable interval. They did not decrease regularly in size towards the colon.

In a rabbit of 41·6 mm. a single pocket was found. It was shaped like a flat round flask, and set in the epithelium so that it produced only a slight bulging of the basement membrane. It had an oval lumen emptying into the intestine and was lined with smooth epithelium, contrasting with the much-folded intestinal layer which was in process of forming villi.

In a human embryo of 13·6 mm. Lewis and Thyng described a duodenal diverticulum (*Fig.* 22). Below the duodenal pocket there were indications of diverticula formation at twelve places along the small intestine. There were transitions between well-defined diverticula and slight irregularities of
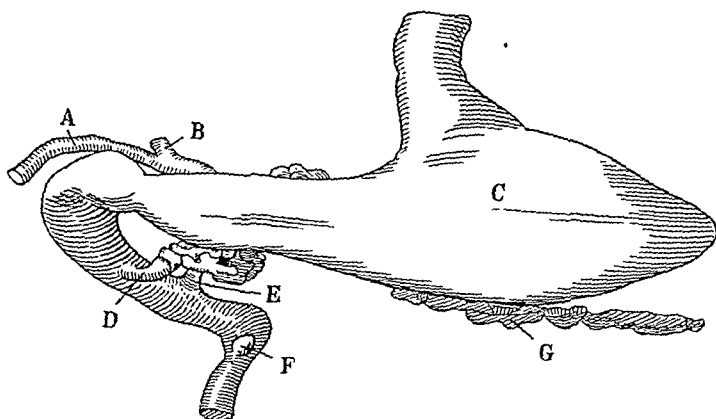
FIG. 22.—Reconstruction of a human embryo of 13·6 mm. showing a duodenal diverticulum. (× 35.) A, Cystic duct; B, Hepatic duct; C, Stomach; D, Ductus pancreatis dorsalis; E, Common bile-duct; F, Diverticulum; G, Dorsal pancreas. (*After Lewis and Thyng*, ' American Journal of Anatomy ', 1907–08, vii.)

the epithelium. In a human embryo of 23 mm. there were thirty-three well-developed diverticula along the small intestine; there were none in the ileocæcal region or in the large intestine. In a more advanced embryo the epithelium in the proximal part of the small intestine was greatly folded and had shrunk from the mesenchyme so that diverticula—even if present—would have been difficult to recognize; but within the umbilical cord the intestine was well preserved, and forty-eight diverticula were counted. In none of these human embryos were diverticula found along the large intestine and vermiform appendix. Originating in the manner described, it is clear that this abnormality may persist as a diverticulum, its lumen communicating with the lumen of the intestine, or it may become a completely closed sac, having no communication with the gut lumen. Lewis and Thyng described this process in a pig embryo. A 20-mm. pig embryo has twelve diverticula in that part of the small intestine which is preserved. There are none along the large intestine. The interesting feature of this embryo is a rather thin-walled epithelial cyst with a few rounded out-pocketings,

found just outside the muscularis of the duodenum, a short distance from the pancreas (*Fig.* 23). The intestine near by presents a solid cylindrical outgrowth which extends to the muscularis, but does not penetrate it. Undoubtedly this was formerly connected with the cyst, although at present it is not directed towards it, and is not where the cyst approaches to the muscularis. It appears that after the stalk became detached, the growth of the intestine carried it along and changed its direction.

Fig. 23.—Section from a pig embryo of 20 mm. The loop of the duodenum is cut in two places. Midway between these is the cyst. The cyst comes in contact with the muscularis in the following sections. A, Pancreas; B. Portal vein; C, Superior mesenteric artery; D, Duodenum; E, Muscularis; F, Cyst; G, Muscularis; H, Duodenum; I, Diverticulum. (× 30.) (*After Lewis and Thyng, 'American Journal of Anatomy'*, 1907–08, vii, 508.)

Fig. 24.—Enterogenous cysts: A, Submucosal; B, Intermuscular; C, Subperitoneal; D, Intramesenteric. ⦀ = Longitudinal muscular coat; ☰ = Circular muscular coat; ⎯ = Mucosa.

It is obvious, too, that the fully developed cyst may occupy any plane in the intestinal wall—submucosal, intermuscular, or subserous—and may occupy any segment of the gut periphery, whether antimesenteric, mesenteric, or any intervening site. Sometimes a subserous cyst situated on the mesenteric border of the gut loses its attachment to the gut wall and occupies a position between the layers of the mesentery more or less remote from the parent gut. (*Fig.* 24.)

From examination of histological sections it is apparent that cysts which at one time were subserous have become invaginated more or less completely into the lumen of the gut, may even have become pedunculated, carrying before them the coats of the gut. That this is the method of production of the case here reported is obvious

when we compare *Fig.* 25 with *Fig.* 18 and Sir Arthur Keith's histological report. Nearly all reported cases of ileocæcal cysts belong to this type of developmental cyst. (*See* case reported by Sir Arthur Keith[4] —R. C. S. Museum, Specimen No. 1220.01.)

VARIATIONS IN THE STRUCTURE OF THE CYST LINING.

In a large number of recorded cases the structure of the cyst wall is complete, the mucosa, submucosa, and muscular layers being unmistakably intestinal. In others, however, there are great variations in the mucosal layer. We find " stratified epithelium ", " cylindrical epithelium of varying heights ", " a few epithelial cells ", " atrophic mucosa ", " tall columnar cells ", " a somewhat stretched layer of columnar epithelium ", " cubical epithelium with traces of submucosa ", " flattened epithelial cells ", " typical stratified epithelium with occasional cylindrical and cuboidal groups of cells ", " stratified ciliated cells ", " columnar ciliated epithelium ", " a single layer of cuboidal epithelial cells ", and even " the inner layer presents the structure of a serous membrane ". Occasionally we find several varieties represented in the same cyst (*see* Miller's, Studgaard's, Hedinger's, and Gfeller's cases). The formation of villi may be complete or incomplete.

FIG. 25.—Diagram showing a subserous enterogenous cyst becoming invaginated into the lumen of the gut.

Many of the changes found in the lining of the cyst cavities can be accounted for by intracystic tension or by inflammatory changes. Others may be explained by the embryological development of the gut. *Fig.* 26 shows a section of the gastric epithelium from an embryo of 22·8 mm., in which it is seen that in places the epithelium is clearly simple, but elsewhere it may show several rows of nuclei, and is perhaps stratified. In embryos of 5·5 and 7 mm. the duodenum usually presents a well-defined round lumen bounded by a two- to three-layered epithelium. In slightly older embryos the epithelium proliferates and vacuoles are formed within it. Later the proliferating epithelium bridges and subdivides the original lumen, as seen in the section of a 10-mm. embryo (*Fig.* 27 *A*).

FIG. 26.—A section of the gastric epithelium from an embryo of 22·8 mm. (× 330.) (*From Keibel and Mall*, ii, 372, *Fig.* 275.)

Occasionally the masses of cells surrounding the vacuoles produce local bulgings of the basement membrane. At 22·8 mm. (*Fig.* 27 *B*) the

out-pocketings are so numerous that the epithelium appears folded, and mesenchyma has begun to extend inwards between the pockets or folds. In sections the vacuoles cannot be distinguished from the main lumen. At 30 mm. (*Fig.* 27 *C*) the vacuoles begin to become confluent so that a central lumen is re-established. " The projections between the vacuoles remain as the foundations of villi." In embryos from 30 to 60 days the duodenal lumen is normally more or less completely obliterated.
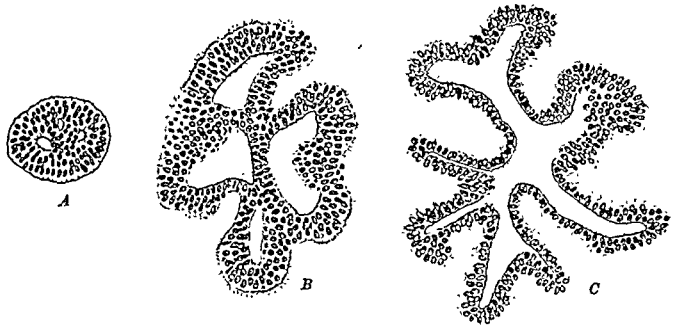
Fig. 27.—Cross-sections of duodenal epithelium. (× 85.) *A*, At 10 mm. The upper cavity is a vacuole, the two lower ones are part of the original lumen. *B*, At 22·8 mm. C, At 30 mm. (*From Keibel and Mall*, ii, 382.)

Kollman[5] states that the epithelium of the developing gut undergoes a regular progression from simple cuboidal to simple cylindrical, and then to stratified epithelium ; from which finally develops the permanent layer of simple cylindrical epithelium, which in the respiratory tract is ciliated. To account for the diversity of cells found lining enterogenous cysts it has been suggested that the sequestered group of cells may retain the characteristics shown by its parent at the time of separation. This is a possibility ; but a much more probable explanation of the varied types of epithelium found lining certain of these developmental cysts and diverticula is afforded by a study of the epithelial misplacements of the intestinal tract. We know that the cells lining the whole primitive intestinal canal are morphologically identical, and that later they become differentiated into the squamous epithelium of the œsophagus, the glandular elements of the stomach, duodenum, small and large intestine, the mucosa of the gall-bladder, and the parenchyma of the liver and pancreas. Nicholson[6] has shown that these fully differentiated cells may de-differentiate when chronically inflamed, and eventually re-differentiate into the cells typical for that particular region, gastric cells in the stomach, intestinal cells in the intestine, gall-bladder mucosa in the gall-bladder, etc. On the other hand, such de-differentiated cells may become re-differentiated, but in a direction other than that of the normal embryonic development. Thus, Nicholson reports the frequent occurrence of gastric glands in the mucosa of gall-bladders as a result of cholecystitis, and has described the presence of gastric glands in a tuberculous ulcer of the colon, and of newly-formed pyloric glands in tuberculous granulations of the vermiform appendix, the differentiation under these pathological stresses being atypical or heterotopic. Along the same lines Nicholson would explain the presence of developmental heterotopic tissues (cardiac glands in the œsophagus, intestinal glands in the stomach, squamous epithelium in the gall-bladder, squamous epithelium in a pancreatic duct, etc.), " since there is good evidence [Meyer[7]] that everyday pathological processes take place even in the embryo and these must surely alter the environment of the cells."

If, then, abnormal differentiation of cells occurs when the surrounding conditions are abnormal—in other words, when the environment is altered—it is not to be wondered at that the cells lining fœtal diverticula and cysts sometimes differentiate abnormally and give rise to the many varieties of epithelium which have been found lining these structures. We shall later refer to instances in regard to which little doubt can be entertained that heterotopic tissue has occurred in and been occasioned by developmental diverticula ; sufficient here to note the fact that in the normal processes of development when diverticula form from the primitive digestive tract, some subtle change takes place in the endoderm lining them, and lung or pancreas, liver or gall-bladder results.

DISTRIBUTION.

Although most of the congenital diverticula have been discovered in the duodenal region and most of the congenital intestinal cysts in the ileocœcal region, there is no reason why they—cysts and diverticula—should not develop in any part of the intestinal tract ; and a study of the literature reveals the fact that they do occur over a wide distribution : in the œsophagus, stomach, duodenum, jejunum, ileum, ileocœcal region, vitello-intestinal tract, vermiform appendix, and sigmoid.

J. W. Larimore and Graham[8] state that in 3446 cases of complete X-ray examinations of the intestinal tract they found diverticula in 105 cases : 9 of the œsophagus, 3 of the stomach, 19 of the duodenum, 3 of the jejunum, and 71 of the colon.

ŒSOPHAGUS.

R. G. Hebb[9] demonstrated a specimen which he had removed from a female, age 31, who died of heart disease at Westminster Hospital. The cyst, the size of a pigeon's egg, was attached to the œsophagus about an inch and a half below the left lobe of the thyroid body, lying in the angle between the œsophagus and the trachea, with the recurrent laryngeal nerve passing over it. There was no communication, and no naked-eye evidence of previous association with the œsophagus. Microscopical examination of the wall of the cyst shows that it is composed chiefly of muscular tissue, and that it is lined by a mucosa. The muscular tissue is striped and unstriped ; externally there is a layer of striped muscle, next
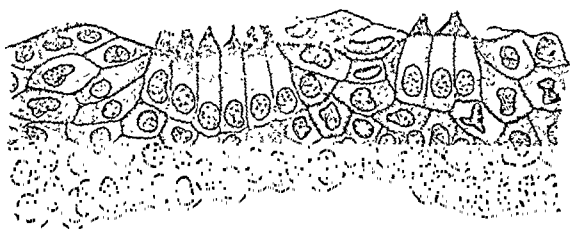
Fig. 28.—Section of the œsophageal epithelium of a negro child at birth, showing many ciliated cells. (× 600.) *(From Keibel and Mall, ii, 361.)*

to this a single layer of unstriped muscle, cut transversely, and next internally are several layers of unstriped muscle, the fibres being arranged parallel to their long axes and to the outline of the cyst. The mucosa consists of two to three layers of cells, the superficial ones *being columnar ciliated* epithelium. Compare with this a section made of the œsophagus of a negro child by Lewis[10] (*Fig. 28*).

Wyss[11] described a tumour found in the body of an adult. It was situated on the posterior aspect of the œsophagus, about one inch above the cardia, and was as big as a medium-sized apple. It contained a gelatinous, milky-coloured fluid, in which were many ciliated epithelial cells. The inner lining, 1 mm. thick, consisted of degenerated ciliated epithelial cells ; the other layers consisted of connective tissue and muscular tissue.

See also Roth's case, p. 49 and *Fig. 37.*

STOMACH.

Gardiner[12] described a stomach, the posterior surface of which is seen in *Fig.* 29. The cardiac end was the size of a tennis ball, and its capacity was 56 c.c. The stomach then became constricted, and beyond the constriction the pyloric half of the stomach resembled a tube. In the furrow at the constriction was an accessory pancreas ; the pancreas was continued through the posterior wall of the stomach and terminated in a papilla just below the lesser curvature. Opening off from the posterior wall of the pyloric tube was a large sacculation, like the dilated finger of a glove, lying parallel with the greater curvature of the stomach. The communication between the pyloric portion of the stomach and the diverticulum comfortably admitted the middle and index fingers. The main pancreas was found in its usual position and showed no anomalies.

FIG. 29.—The posterior surface of the stomach, showing a large diverticulum of the pyloric portion, and an accessory pancreas. A, Cardia : B, Location on the mucous membrane of the papilla for the opening of the excretory ducts ; C, Epiploic vessels ; D, Diverticulum ; E, Pylorus ; F, Accessory pancreas ; G, Fundus of stomach. (*From the ' Journal of the American Medical Association ', 1907, xlix.*)

A. W. Pritchard[13] operated on a boy, age 15, who from infancy had been subject to attacks of ' wind colic '. The attacks of abdominal pain and swelling had been occurring irregularly about every two months, sometimes with and sometimes without diarrhœa. For the ten days prior to the operation he had been kept in bed and suffered from six violent attacks with diarrhœa. The boy stated, " The lump comes up with pain that makes me groan ; the lump goes, and then the pain passes off." " On opening the abdomen a huge mass was found pushing forward the transverse colon. It looked like a huge intussusception, or a hernia of the stomach between the layers of the mesocolon. In fact when I had incised the peritoneum over it, it was so like a stomach that I prolonged my skin incision to prove that the stomach was in its normal place. I opened the cyst and about 15 oz. of fluid were let out. I then proceeded to free it from its attachments. stripping off the peritoneum with considerable difficulty and hæmorrhage. A pedicle was found at the vertebral attachment and tied off." The specimen was shown at the Pathological Society of Great Britain and Ireland, and reported on thus : ' Microscopically the cyst wall was composed

of gastric mucosa. The glandular layer showed an excess of mucoid-forming cells, but otherwise the normal appearances were not departed from. The submucous, muscular, and serous layers were all represented, and were typical.'"

Ahrens[14] reported an operation on a female 17 years old in whom he found and removed a cyst containing four litres of thick reddish-brown fluid. The cyst was situated behind the peritoneum on the right side of the abdomen. In appearance it suggested an hour-glass stomach and 26 cm. of small intestine. Microscopical examination of the cyst wall revealed a structure identical with that of a stomach and small intestine, save that the mucosa in different sections consisted of stratified and cuboidal cells, stratified ciliated cells, tall columnar, and flat cells. The fluid in the cyst was weakly acid, and digested egg albumen on the addition of hydrochloric acid. There were multiple ulcers in the pseudo-stomach.

Fig. 30 is a drawing from a specimen in the Westminster Hospital Museum (No. 455.A). In the pyloric portion of the stomach immediately
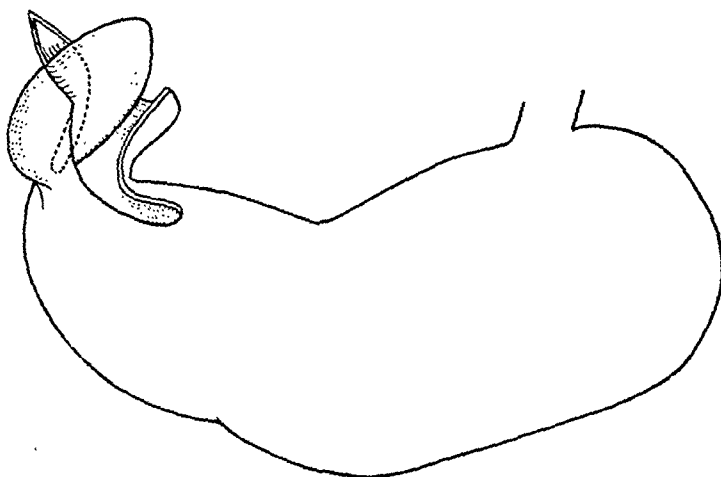
FIG. 30.—Developmental enterogenous cyst in the pyloric end of the stomach, immediately adjacent to the pylorus. (*Westminster Hospital Museum*, No. 455.A.)

adjacent to the pylorus is a firm-walled cyst 2 × 1 in. The reflection of the gastric mucosa on to the anterior and outer surface of the cyst is shown in the drawing; elsewhere the attachment of the tumour is indicated by the dotted line. " The stomach is not dilated, nor is the pylorus distorted, showing that no obstruction was caused. From a child 6 months old, who died from perforation of a typhoid ulcer in the ileum. The cyst contained glairy fluid." A recently cut section of the cyst wall where it protrudes into the lumen of the viscus shows it to be covered by pyloric mucosa; this lies upon a muscular coat. The cyst is lined by " flattened gland cells ".

There is in the Royal College of Surgeons Museum a pedunculated diverticulum $2\frac{3}{4} \times 1\frac{1}{2}$ in.; its wall is $\frac{1}{6}$ in. thick, and the lining mucous membrane exhibits rugæ resembling those of a normal stomach. Microscopical examination of the wall of the diverticulum shows the general structure of a stomach. The central canal in the pedicle is lined by a mucosa consisting of short glands which are mucus-secreting throughout their length ;
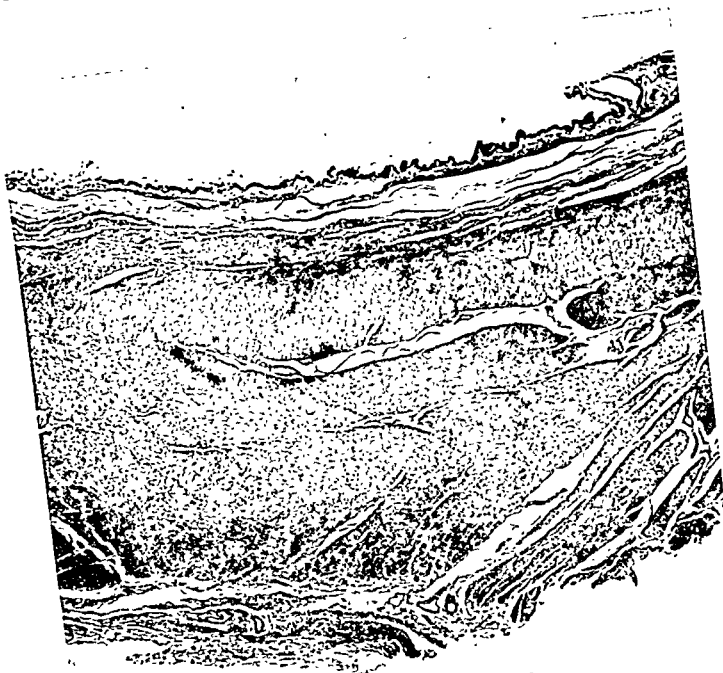
× 15
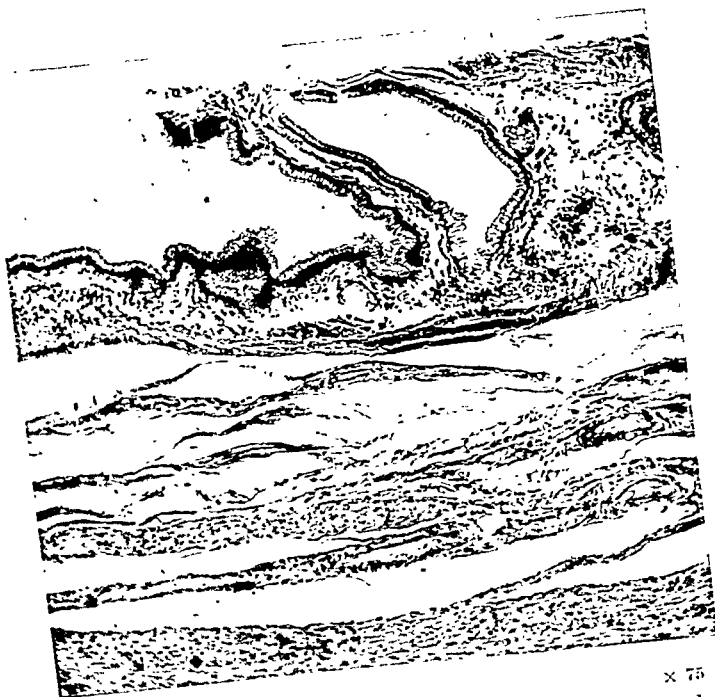
× 75

FIGS. 31, 32.—Sections of developmental enterogenous cyst, enucleated from the wall of the stomach and from the adjacent pancreas. (*Westminster Hospital Clinical Reports*, 20–1116; Section No. 3884.A.)

the submucous layer is only slightly marked, and a muscularis mucosæ not recognizable; there are two layers of muscle; outside these is a broad layer of dense and highly muscular connective tissue. This diverticulum was removed by Mr. Neil Sinclair from a child 4 months old. It lay in the angle formed by the duodenum and jejunum. The pedicle was directed upwards across the anterior surface of the termination of the duodenum; it passed through a hole in the transverse mesocolon, and around this aperture the mesocolon was much thickened. The diverticulum contained blood and mucus. There was no torsion of the pedicle.

Figs. 31 and 32 show low- and high-power views of a section through the wall of a cyst removed by Mr. Rock Carling. The patient was a female, age 39. The cyst, the size of a walnut. was embedded partly in the pancreatic substance and partly in the muscular wall of the stomach. To remove it, it was necessary to incise the muscular wall of the stomach on the upper aspect of the cyst. The cyst contained a few minims of turbid fluid. It possessed a fibromuscular coat 4 mm. thick, and was lined by tall columnar mucus-secreting cells, by low cuboidal cells, and by flattened cells.

DUODENUM.

Many instances of congenital intestinal diverticula of the duodenum have been recorded. particularly in the second portion. Now that screen examinations after a bismuth meal are so constantly made, duodenal diverticula have ceased to be looked upon as great rarities.

Spriggs[15] found that the situation of the diverticula in the reported cases of Buschi, Bauer, Wilkie, Bosch, Ritchie, and McWhorter was as follows:

Out of 57 cases: 11 in the first part; 2 in the first and second parts; 41 in the second part; and 3 in the third part of the duodenum.

C. M. Jackson[16] reported a case of duodenal diverticulum which was found post mortem in a man, age 50, who had died of pneumonia. " It extends upwards from the upper wall of the transverse duodenum (*Fig.* 33). The sac measures about 3·5 cm. in the vertical direction, 3 cm. in the transverse width, and 2 cm. antero-posteriorly (being deepest in this direction in the lower part of the sac). The neck of the sac is constricted, the aperture of communication with the duodenum measuring about 5 mm. in diameter. The diverticulum is in contact, posteriorly, with the aorta and vena cava.
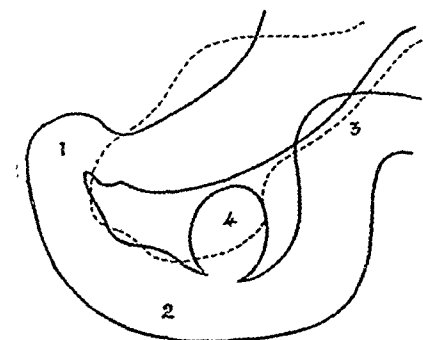
Fig. 33. — Diverticulum of the duodenum. 1, First part of duodenum; 2, Transverse duodenum; 3, Duodenojejunal angle; 4, Duodenal diverticulum. Pancreas is shown in dotted outline. (*After Jackson, 'Journal of Anatomy and Physiology'*, 1902, xlii, 219.)

Anteriorly, it is in contact with the superior mesenteric artery and vein *below*, and with the posterior surface of the head of the pancreas above. The wall of the sac is thin (0·7 to 0·8 mm.), and in general resembles the neighbouring duodenum in structure. It is lined by mucous membrane, somewhat reduced in thickness, and is limited externally by a thin fibrous tunic. Between *these*

is a muscular coat, only 0·1 to 0·15 mm. in thickness, but everywhere distinct." *Fig.* 33 should be compared with *Fig.* 22—a drawing by Lewis and Thyng of a duodenal diverticulum in a 13·6 mm. embryo.

Specimen No. 6283.1, Royal College of Surgeons Museum, shows two diverticula of the duodenum (*Fig.* 34). Immediately adjacent to the bile papilla is a round aperture in the wall of the bowel, measuring about half an inch in diameter, and leading into a diverticulum of somewhat pyriform shape, and $1\frac{3}{4}$ in. long. The wall of the pouch consists of the mucous and submucous coats of the bowel. On the opposite side of the bile papilla is a small aperture leading into a pouch the size of a pea. The patient, a man, age 72, died of a strangulated hernia. There were several small diverticula in various parts of the small intestine.

In the Westminster Hospital Museum No. 455B is a large diverticulum of the first part of the duodenum. Its vertical diameter is $1\frac{3}{4}$ in., its transverse diameter $1\frac{1}{4}$ in., and its
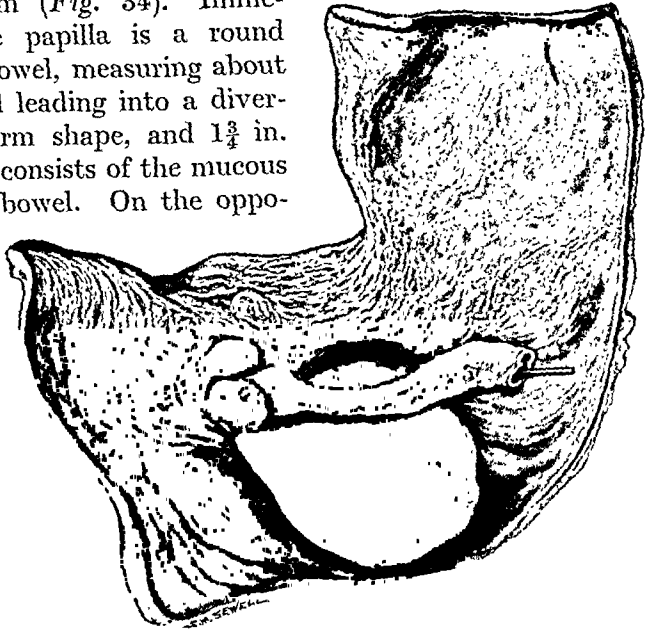
FIG. 34.—Two diverticula of the duodenum, the openings into which are situated one on each side of the bile papilla and immediately adjacent to it. (*R.C.S. Museum, No.* 6283.1.)

depth about 1 in. Microscopically the lining of the diverticulum was found to be normal mucosa, and the muscular coats were hypertrophied (*Fig.* 35).

Roth[17] records a case occurring in a newly-born male child who lived but a few minutes; the abdomen was greatly distended; there was a large thin-walled cystic tumour, lying on the stomach and duodenum; in the illustration the tumour is shown displaced downwards (*Fig.* 36). It will be noticed that the tumour is in two parts, A and B. The two sacs were quite separate, but they had a common pedicle in the region of the pancreas and the duodenum. Dissection of this region revealed a short pipe-like connection 1 cm. long between the two cysts. This

FIG. 35.—Section through the wall of a duodenal diverticulum, showing a normal mucosa, and hypertrophied muscular coats. (*Westminster Hospital Museum, No.* 455B. *Section No.* 199.)

intercommunicating channel was lined by cylindrical epithelium of varying heights. No connection was discovered between the cysts and the lumen of

the intestinal canal, but at the posterior surface of the pedicle was a layer of unstriped muscle which was thought to have been torn from the wall of the duodenum.   Sections of the cyst wall revealed all the layers of the intestinal wall ; in places the mucosa was thin.   c is an enterogenous cyst in the right posterior mediastinum, situated close to the œsophagus, and evidently derived from it.   Its wall had a structure closely resembling that of gut, save that the cells of the mucosa were flattened from intracystic pressure.
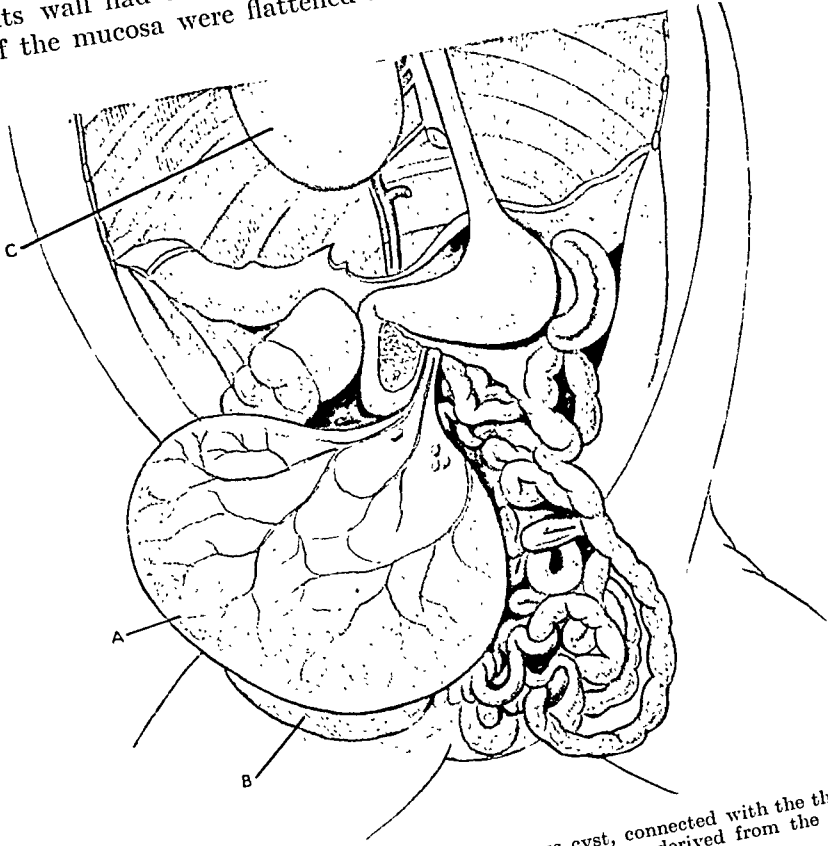
FIG. 36.—A and B, Developmental enterogenous cyst, connected with the third portion of the duodenum. C, Cyst in right posterior mediastinum, derived from the œsophagus.
(After 'Virchow's Archiv', lxxxvi, Taf. xv.)

Oliver Waugh[18] reported a cyst connected with the second portion of the duodenum, found at an operation for persistent vomiting in a child 19 days old.   The cyst, the size of a tangerine orange, was retroperitoneal, and was intimately connected with the posterior wall of the second portion of the duodenum.   The gut being tightly stretched over the cyst had occasioned the obstructive symptoms.   The cyst wall possessed well-marked inner circular and outer longitudinal muscular coats.   I think there can be no doubt that the case, like Roth's, is a developmental enterogenous cyst, derived from the second part of the duodenum.

Sanger and Klopp[19] described the condition found in the abdomen of a newborn child (Fig. 37).   The labour was very difficult and protracted, and

the child died before the delivery was completed. The viscera were trans-
posed. The heart occupied the right side of the chest. The stomach was
situated in the right upper abdomen. The liver filled the left hypochondrium.
" Instead of the spleen, in the right hypochondrium were 16 completely
isolated lobules of spleen tissue—together forming a mass equal to that of the
normal spleen." 'The abdomen contained five cysts—their situation being
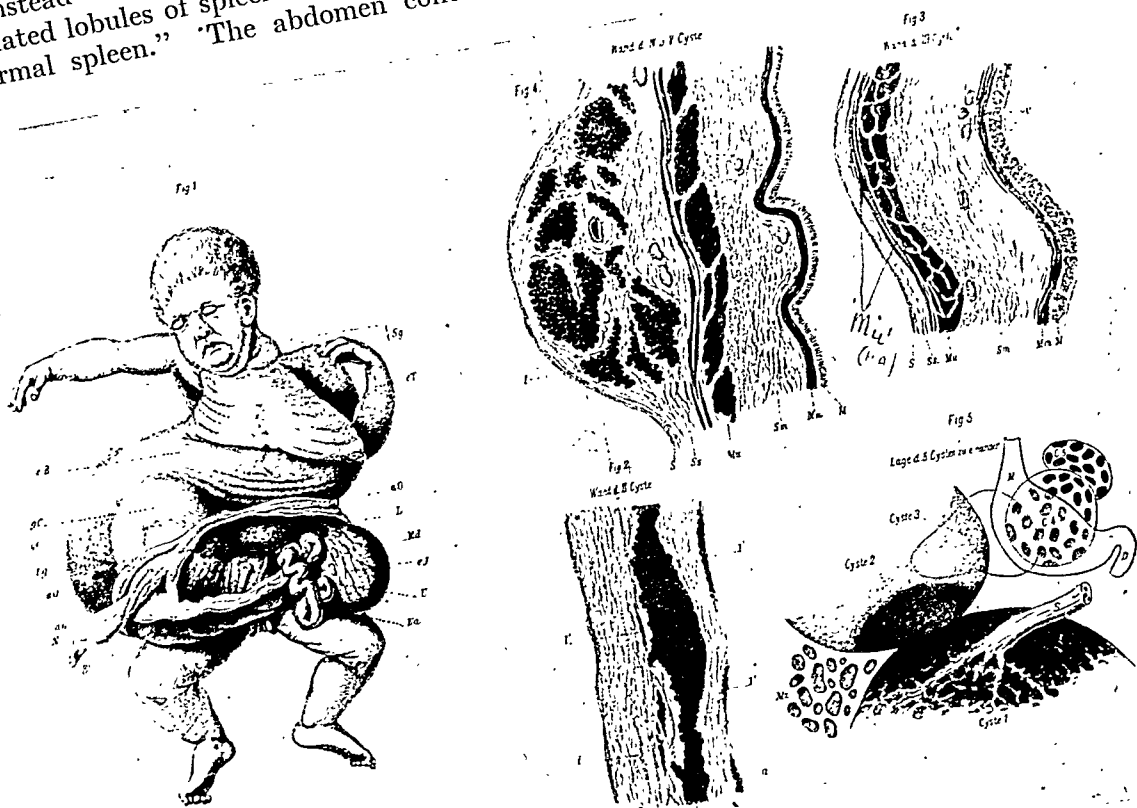
FIG. 37.—Abdomen of a new-born child in which there were five developmental enterogenous
cysts. The walls of these contained liver substance.

Fig. 1.—General appearance of the child after opening the abdomen. gC and gC', The
largest of the cysts; Lg, Scattered nodules of liver substance; L, Right lobe of liver, in
the left hypochondrium; Bl, Bladder; N, Umbilical cord; U, Urachus.
Figs. 2, 3, 4.—Sections of the various cyst walls. M, Mucosa; Mm, Muscularis mucosæ;
Sm, Submucosa; Mu, Muscular coats; l, l', Liver substance; i, Connective tissue.
Fig. 5.—Relation of the five cysts to each other. Mz, Lobules of spleen.

(From 'Archiv f. Gynäkologie', 1880, xvi, 415, Taf. vii.)

shown in Fig. 37 [Fig. 5]. The largest cyst was the size of the child's head;
its circumference was 30·5 cm. The anterior surface of this cyst over an area
about 7 cm. in transverse diameter was composed of a thin layer of a dark
brown substance 1·5 to 2 mm. thick. This was subdivided into small lobules.
This substance looked like liver, and microscopical examination proved it to
be so. For some distance from the main mass of liver substance small

isolated masses could be seen accompanying the vessels which ran in the wall of the cyst. The pedicle of the cyst was attached about the centre of the mass of liver substance, and this pedicle ran upwards towards the duodenum. I regret that the exact attachments of this pedicle are not described. The cyst contained about 300 c.c. of dark yellow mucoid fluid in which bile was present. When microscoped the fluid was found to contain flattened cells and low cubical epithelial cells. The wall of the cyst consists of an outer peritoneal surface lined by closely interwoven connective-tissue fibres and some compressed and atrophied unstriped muscle fibres. Immediately above this cyst was a second, 23 cm. in circumference. These were adherent to one another over an area the size of a shilling piece—but there was no communication between the two cavities. The whole surface of this second cyst was covered by a layer of liver tissue, thickest where the two cysts were opposed. The structure of its wall is shown in *Fig.* 37 [Fig. 4], in which it will be seen that a layer of liver structure lies between the inner and outer connective-tissue planes. On following the pedicle of the first cyst towards the duodenum a third cyst was found, a little bigger than a walnut. The wall of the cyst was 1½ mm. thick, and its structure was identical with that of the intestinal wall, as shown in *Fig.* 37 [Fig. 3] : a mucosa possessing no Lieberkühn's glands, a well-developed muscularis mucosæ, a submucosa, then a well-developed circular muscular layer, a longitudinal muscular layer, subserous layer, and peritoneum. Above this and connected with it, and behind the stomach, was a fourth cyst, smaller than the third. Its outer surface was covered with tiny masses of liver substance of varying thickness. The structure of the wall (*Fig.* 37) [Fig. 4] is identical with that of gut, but there are islets of liver tissue in the sub-serosa. Above this cyst is a fifth, which macroscopically and microscopically is identical with the cyst last described.

Sanger and Klopp came to the conclusion that the first cyst was developed from an accessory liver, and that the primitive gall-bladder had undergone a cystic degeneration ; that the second cyst must have been developed from the bile-duct of the accessory liver, and that this also had undergone cystic degeneration ; and that cysts 3, 4, and 5 were intestinal cysts. That these are enterogenous cysts there can be no doubt. The occurrence of liver cells in their walls is of great interest, and I have come across no other cyst of intestinal origin showing this structure. Seeing, however, the fairly common occurrence of pancreatic tissue in diverticula, it was only to be expected that liver substance would be found in enterogenous diverticula and cysts ; for with our knowledge of the heteromorphoses of the intestinal tract, it is not surprising that the cells lining diverticula of the fœtal entoderm in the vicinity of those buds which grow out and form the liver should themselves display the same power and differentiate into liver cells. Although the structure of cysts 1 and 2 only *incompletely approximate* to that of the intestinal wall, still the presence of a serosa, connective tissue, compressed muscle fibres, and the occurrence of shed epithelial cells (flattened and cubical) in the fluid contents of the cysts, is sufficient justification for the assumption that these too belong to the group of developmental entero-genous cysts.

JEJUNUM.

William Major,[20] under the heading " Constriction of the Jejunum by a Congenital Prolongation of its Coats ", describes a case of intestinal obstruction in a pregnant woman, age 37. The site of obstruction was between three and four inches from the duodenojejunal flexure. At this point a diverticulum arose from the anterior surface of the jejunum, encircled the gut, and formed a knot which could not be untied.

Helverstine[21] found at a post-mortem on a male, age 70, who died of uræmia consequent on hypertrophy of the prostate, 58 diverticula in the first 95 cm. of the jejunum. These varied in size from $2 \cdot 5 \times 2$ cm. to $0 \cdot 5 \times 0 \cdot 3$ cm. They were all situated along the mesenteric border of the jejunum. The large diverticula were near the duodenum, and diminished in size as the distance from the duodenum increased. Helverstine gives a summary of 27 cases of diverticula of the jejunum reported in the literature. Commenting on the condition he says : " Such diverticula in the beginning of their formation are of the true type, containing all the coats of the intestinal wall, as in the case of the smallest pockets found in my specimen and in the specimen described by Klebs.[22] Later, due to progressive atrophy, now accelerated by increased pressure from within, the muscle fibres disappear and a large diverticulum of the false type is found."

Braithwaite[23] and J. Allan Berry[24] have reported cases of multiple diverticula of the jejunum. Braithwaite's specimen is in the R.C.S. Museum (No. 6377.1).

Buchwald[25] reported a case in which he found two cystic tumours, one 10 cm. long, the other 17 cm. long, 4 cm. apart, arising from the jejunum about 50 cm. from the duodenum ; these communicated with the gut by a small opening. Microscopical examination showed the diverticula lined by atrophic mucosa ; the walls consisted mainly of connective and fibrous tissue, with a few muscular fibres.

John L. Hunter[26] described a cyst found in a child who died when seven days old. Lying along the mesenteric border of the jejunum and between the two layers of the mesentery were two cystic swellings. The jejunum was stretched transversely upon these swellings so that its lumen was slit-like in cross-section. The cysts were found to communicate with one another at the intestinal border of the mesentery by an opening 1 cm. in diameter. One loculus measured 55×43 mm., the other 68×41 mm. The walls contained all the elements found in the wall of the intestine, but the most careful dissection showed no communication between the lumen of the cysts and that of the intestine.

Robert T. Miller[27] reported a case of intestinal obstruction due to an enterogenous mesenteric cyst causing volvulus in a female child operated upon when four days old. On the mesenteric side of the jejunum, about 12 cm. from the pylorus, was a cystic tumour, measuring 4 cm. in its long axis and 3 cm. in its transverse axis. The cyst lay between the layers of the mesentery, intimately connected with the jejunal wall ; for a distance of 4.5 cm. the bowel was greatly compressed by the subjacent mass, being flattened out into a ribbon-like band 1.5 cm. across at its widest point. The

cyst was lined by a single layer of columnar cells; over the greater portion of the cyst wall these were thrown up into well-developed villi. The villi were of their maximum size in the region most remote from the gut, gradually diminishing in height and number as the gut was approached; at the same time the epithelial cells diminished in height, becoming low columnar, then cuboidal, and finally over that portion subjacent to the lumen of the bowel the epithelium was quite flattened out. Below this layer was a submucosa, then two well-developed muscle layers, arranged at right angles to one another. As the bowel was approached, the inner muscle layer split into two portions and became continuous with the inner circular muscle layer of the jejunum. The external layer of muscle in the cyst wall remained intact and was directly continuous with the external longitudinal muscle of the bowel, thus forming a muscular envelope common to them both. We have here, then, an intermuscular enterogenous cyst, projecting between the layers of the mesentery.

Norman Moore[28] reported the following case : " The intestines of a man, age 40, showing three diverticula in the first three feet of the small intestine, and a congenital stricture at the commencement of the jejunum. The diverticula are each an inch long and about as much in diameter, and are on the mesenteric side of the intestine. Their walls consisted of all the intestinal coats and they were not mere hernial protrusions."

Von Puschmann[29] found in the abdomen of a boy, age 6, who had died from general peritonitis, a cyst attached to the jejunum 25 cm. from the duodeno-jejunal flexure (*Fig.* 38). The cyst was situated on the mesenteric aspect of the gut. It was bilocular; the larger division is described as being as big as ' a man's fist ', the smaller the size of ' an apple ' ! The larger division was situated in front of the mesentery, the smaller was post-mesenteric. The cyst was attached to the gut over an area the size of a ' 5 shilling coin ' ! A part of this attachment had been torn, with the result that there was a hole in the cyst and another in the adjacent portion of jejunum. Through this hole fæces had escaped into the general peritoneal cavity, resulting in the death of the patient. The structure of the cyst wall resembled that of gut, and the two layers of muscle were found to be continuous with the corresponding layers of the adjacent jejunum.

Fig. 38.—Bilocular developmental enterogenous cyst attached to the jejunum. (*From 'Deutsche Zeitschrift für Chirurgie'*, 1904, 109.)

ILEUM.

Roth[17] reported a case of a diverticulum situated 66 cm. from the ileocæcal valve. It was attached to the mesenteric border of the ileum by a pedicle 11 mm. long, through which it communicated with the lumen of the gut (*Fig.* 39). The wall showed the structure of normal intestine. This case was presumably a Meckel's diverticulum.

FIG. 39.—Diverticulum of the ileum. (*After 'Virchow's Archiv'*, lxxxvi, *Taf.* xv, *Fig.* 1.)

Tiedemann[30] found a similar cyst in a full-term fœtus. It was pear-shaped, pedunculate, and attached to the convexity of the intestine. It was $14\frac{1}{2}$ lines long and 7 lines wide. Its cavity communicated with that of the intestine by means of a canal in the pedicle large enough to admit a probe.
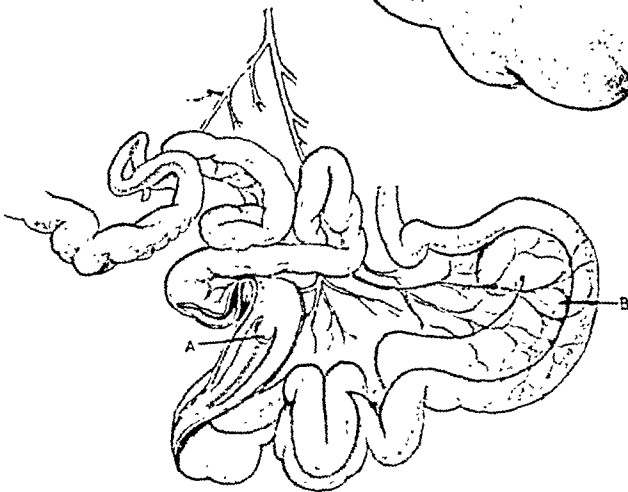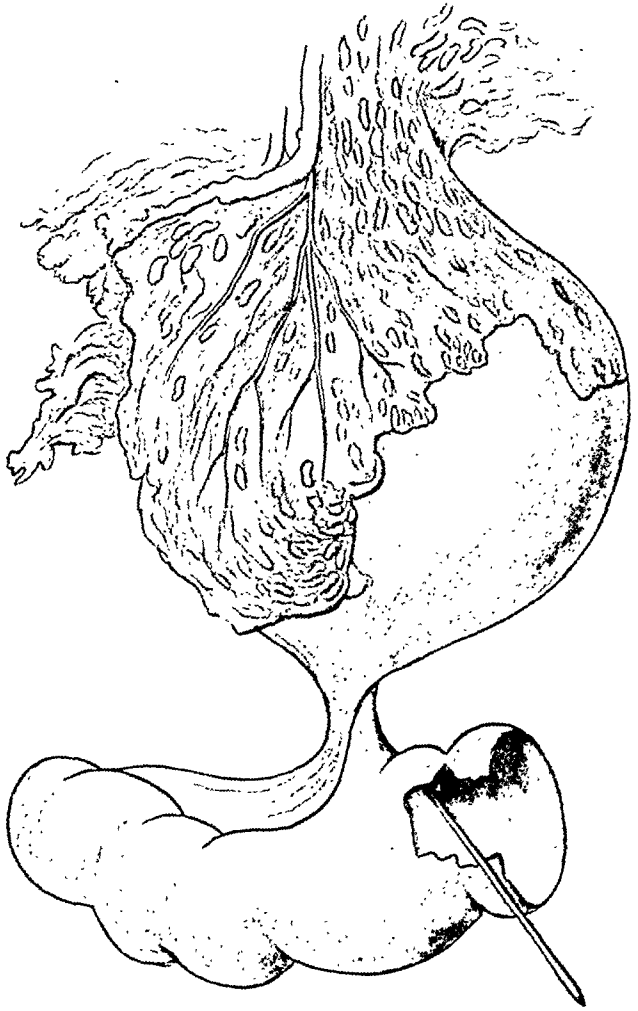
FIG. 40.—Developmental diverticulum of the ileum, situated between the layers of the mesentery. A, Mouth of diverticulum; B, Diverticulum. (*After 'Virchow's Archiv'*, lxxxvi, *Taf.* xv, *Fig.* 3.)

Roth[17] reported another case in which a cystic tumour 10 cm. long was situated between the layers of the mesentery of the ileum. The opening into the gut was situated 14·5 cm. above the ileocæcal valve (*Fig.* 40). Section of the tumour wall showed all the structures of the intestinal wall, with cylindrical epithelium, goblet

cells, villi, Lieberkühn's glands, Peyer's patches, a well-developed muscularis mucosæ, submucosa, two layers of muscular fibres, and peritoneum. This case is of interest, in that the cylindrical epithelium lining the cyst was ciliated. At the distal end of this intramesenteric diverticulum, a cyst was seen the size of a bean, also lying within the mesentery. The structure of the wall was similar to that of the intestine. The epithelial lining was composed of cylindrical cells, some with and some without cilia. In this subject were also found a gut-lined cyst connected with the œsophagus, and another connected with the 3rd portion of the duodenum (*see Fig.* 36).

Hilton Fagge[31] says : " One of the preparations in our Museum is a specimen of a diverticulum distinctly stated to have been situated above the middle of the ileum. This diverticulum is as large as a hen's egg, and has an unusually rounded form, but it appears to possess all the intestinal coats.

F. van der Bogert,[32] in a female child, age 5 years, found a large cyst about 18 cm. in its longest diameter, two somewhat smaller cysts (containing about 1·5 litres of fluid), and ten small cysts. " All the cysts had their origin in the mesentery of the ileum. There was no well-defined pedicle, the attachment being in the mesentery and extending along the intestine for a space of about 12 cm." " Under the microscope the outer surface was seen to be covered with normal peritoneum. The subserous tissue contained many congested blood-vessels. Beneath the connective tissue were found many smooth muscle fibres arranged in bundles and forming two distinct layers running at right angles to each other, the arrangement being characteristic of the structure of the intestines. No epithelial lining was detected."

Hennig[33] reported the case of an abdominal cyst the size of a moderately filled adult stomach. It occurred in a newborn child, and filled the anterior part of the abdomen. The sac measured $8\frac{1}{2} \times 5\frac{1}{2} \times 4$ in., lay within the mesentery, and did not communicate with the intestine. It held 100 grm. of clear, pale red, somewhat viscid, slimy fluid ; its inner wall contained intestinal glands, and was covered with cylindrical epithelium.

Shallow[34] reported a case of entero-mesenteric cyst occurring in a child 5 months old, with a greatly distended abdomen, in whom a provisional diagnosis of Hirschsprung's disease was made. On opening the abdomen a cyst was found which was in direct contact with the small intestine, and extended from four inches from the ileocæcal valve for a length of 40 cm. ; 1500 c.c. of clear amber-coloured fluid were evacuated from the cyst, and the cyst with the adjacent portion of small intestine was removed. There was no communication between the cyst and the lumen of the gut. Section of the wall showed three coats of non-striated muscle, an outer longitudinal, a middle circular, and an inner longitudinal. It was lined in parts by columnar epithelium. The epithelial lining was not constant, but in places the columnar cells were several layers thick, and some of the cells ' appeared to be ciliated '.

Strode and Fennel[35] report a case in a child operated upon when four days old for intestinal obstruction. A tumour was found in the lower ileum, in size about 1·5 × 1 cm., causing the anterior surface of the ileum to protrude, about 6 cm. proximal to the ileocæcal junction. The gut distal to the cyst was collapsed, and distended above it. An incision was made into the wall of the ileum and the cyst was shelled out. It was then found that

another cyst completely occluded the lumen of the intestine, dilating it to a diameter of about 3 cm. This portion of gut was excised. The small cyst was " lined by papillomatous and flattened squamous epithelium, and had a muscular wall continuous with the musculature of the intestine." We have, in this interesting case, two cysts of intestinal origin, one intermuscular and the other within the lumen of the gut (analogous to those cysts which, moving centrifugally, ultimately become intramesenteric).

Eve[36] described two mesenteric cysts. One occurred in a child, age 11 weeks, in whom an abdominal tumour could be felt (the size of a small kidney). It could be freely moved all over the abdominal cavity. The swelling could be felt per rectum. A cyst the size of a tangerine orange was found between the layers of the mesentery of the small intestine (*Fig.* 41). Two ounces of fluid were aspirated from the cyst, the aperture was closed, and the cyst sutured into the wound. A week later the cyst was incised, washed
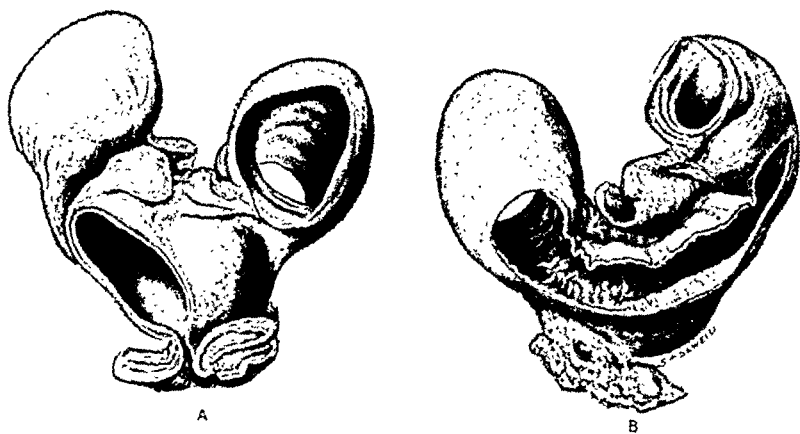
FIG. 41.—Mesenteric cyst. A shows the cyst and its attachment by operation to the abdominal wall; B shows the diminution in size of the lumen of the ileum produced by the cyst. ('*Med.-Chir. Trans.*' 1897–8. Specimen No. 1220.1, *R.C.S. Museum.*)

out. and a drainage tube inserted. A month later the child died following convulsions. When microscoped, no endothelial or epithelial lining was found, but just beneath the surface a thin layer of unstriped muscle cut longitudinally was seen, then a thick layer of muscle divided transversely, followed by another thick layer composed of several fasciculi running parallel to the surface. From this structure it can safely be assumed that we have here a developmental enterogenous cyst.

Since writing the above I have been examining Eve's specimen in the Royal College of Surgeons Museum, and was shown a microscopical section of the wall of this cyst which was made by Mr. Shattock when the specimens were being re-arranged. From an examination of this section (*Fig.* 42) it will be seen that my assumption that this was a developmental enterogenous cyst is justified: for although my diagnosis was founded on the original description of the muscular layers in the wall of the cyst, Mr. Shattock's section reveals a mucosal lining having intestinal characters, and places the cyst without any doubt in the category of enterogenous cysts. The case is thus described by Mr. Shattock: " The wall of the cyst is comparatively

thick, and, beneath its lining membrane, consists of a well-developed layer of tawny muscle fibre. Microscopic sections show that the wall is furnished with a double layer of unstriped muscle fibre, and in certain spots with a mucosa having intestinal characters, i.e., provided with crypts embedded in lymphatic tissue. Beyond the areas referred to, the mucosa becomes thinner and thinner, the crypts being much more and more oblique, as if from pressure, till the proper structure ceases to be recognizable. The calibre of the bowel is considerably reduced by the pressure of the swelling. The cyst is probably a fœtal diverticulum of the intestine of which the original communication has become closed."

Wallman[37] reports the following specimen in the Joseph's Akademie, Vienna. One piece of small intestine, 48 cm. long, contained thirty-seven diverticula varying in size from a pigeon's egg to that of a bean. Of these, thirty lay between the layers of the mesentery. Many of them were in the closest possible apposition to one another.

Studsgaard[38] described a cyst which he found in the mesentery of a girl 14 years old. The abdomen had been distended for years, and had been tapped on two occasions, three and ten years previously. The anterior layer of the mesentery over the tumour was incised, the cyst wall was punctured, and 2000 c.c. of chocolate-coloured fluid withdrawn. The cyst was enucleated, difficulty being experienced in the region of the pedicle, which was a funnel-shaped prolongation of the cyst towards the spine. This was ligatured, cut across, and the stump cauterized. "The cyst wall was in perfect agreement with the wall of the intestine."

Terrier and Lecène[39] reported an example, found post mortem, which was situated in the mesentery of the small intestine, 50 cm. above the ileocæcal valve. Its walls contained muscular fibres, and it was lined by columnar epithelium. These authors in their
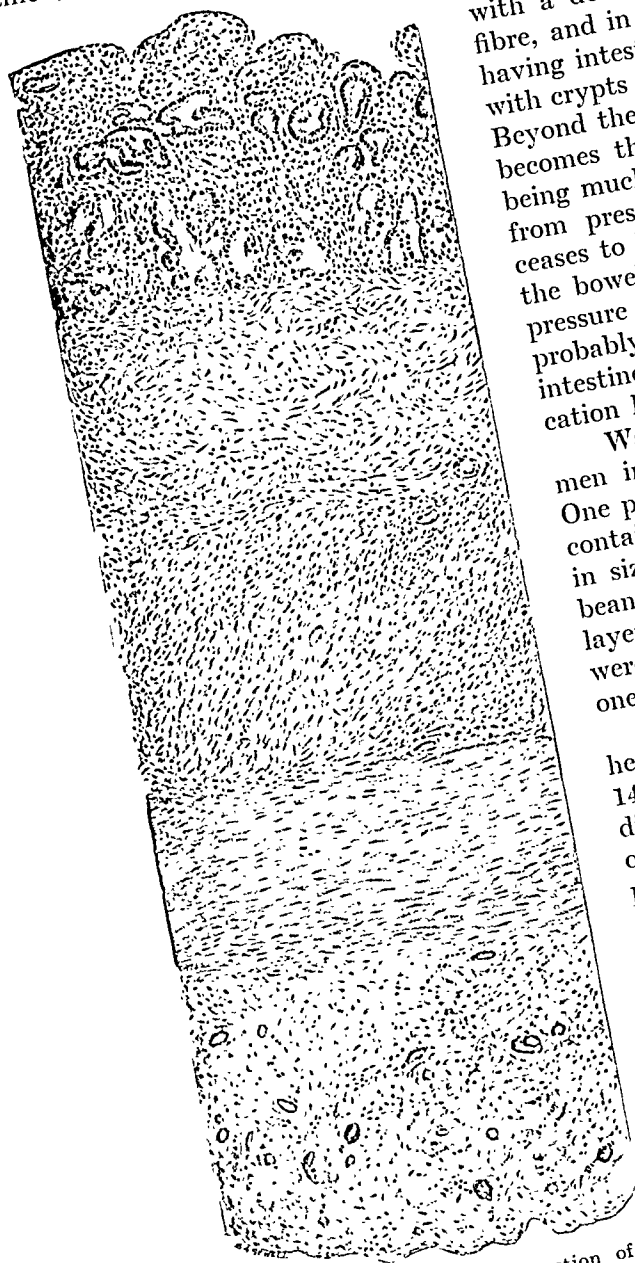
Fig. 42.—Microscopical section of Eve's mesenteric cyst, showing a mucosal lining and two layers of unstriped muscle fibres.

valuable communication suggest for the type of cyst we are considering, and which on section shows the structure of the intestinal wall, the name 'enteroides'.

Gfeller[40] operated on a female child, 11 years of age, for intestinal obstruction. He found one coil of small intestine had undergone rotation
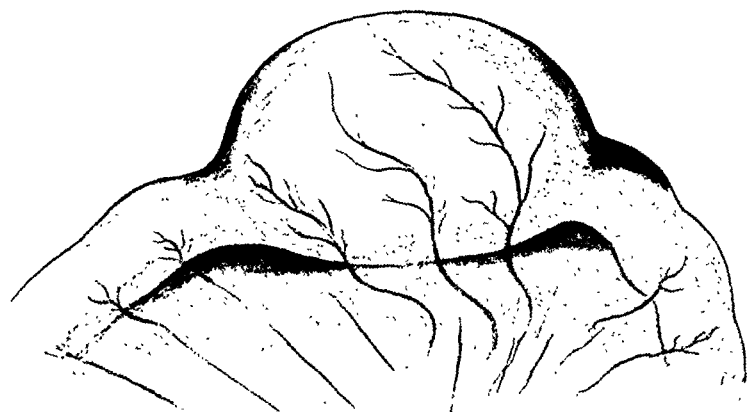
FIG. 43.—Enterogenous cyst situated in the ileum, producing volvulus and intestinal obstruction. (*After Gfeller, 'Deutsche Zeitschrift für Chirurgie', 1902, 330.*)

through 360°. On following the dilated portion a tumour the size of an orange was found in the pelvis. It was situated on the antimesenteric border of the bowel, and seemed part of it (*Fig. 43*). On delivering the
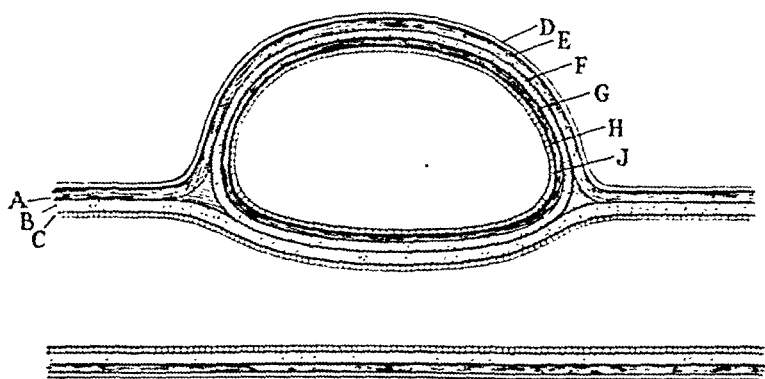
FIG. 44.—Longitudinal section through the tumour and intestine shown in *Fig. 43*. The enterogenous cyst is seen to be intermuscular. A, Long muscle ; B, Circular muscle ; C, Mucosa ; D, E, F, G, Serous. subserous. longitudinal, and oblique muscular fibres ; H, Muscular fibres, partly oblique and partly longitudinal ; J, Mucosa. (*After Gfeller, 'Deutsche Zeitschrift für Chirurgie', 1902, 330.*)

intestine the volvulus was easily untwisted and the contents of the dilated part passed easily along the lumen of the bowel into the distal contracted loops. The tumour was 7·8 cm. long. cystic. unilocular, covered with peritoneum and with the longitudinal muscle of the bowel (*Fig. 44*). These

were divided and the tumour easily shelled out by peeling the longitudinal muscle from it, and by separating it from the circular muscle fibres. It had no connection with the lumen of the intestine. The wall of the cyst was composed of three layers of unstriped muscle; the epithelial lining consisted in greater part of stratified epithelium, with occasional groups of cylindrical and of cuboidal cells.

Frankel's[41] case was found in a female child who died at the age of 3 days from intestinal obstruction. There was a globular swelling 2·5 cm. in diameter at the end of the ileum, between the muscular coats of the gut. Histological sections were not made till thirty years afterwards; the walls of the cyst were found to contain muscular fibres, but there was no discoverable mucosa. It would be difficult to describe a case more graphically and in fewer words than those in which Gfeller summarizes this one: " Intestinal obstruction; fæcal vomiting; energetically purged; death."

Seligmann's[42] case was 6 cm. from the ileocæcal valve. The structure of the cyst wall was similar to that of the intestine, and the cyst was situated in the muscularis mucosæ.

Dittrich[43] reported one case 30 cm., and another 60 cm., from the ileocæcal valve. In the first case the histological section was similar to that of small intestine, including Lieberkühn's glands. In the second the cyst wall presented the structure of small intestine, but was thinner; the outer muscular layer was directly continuous with that of the gut.

Kulenkampff[44] records a case in a patient, 3 years old, who died of intestinal obstruction from torsion of the small intestine. There was seated in the mesentery, 40 cm. from the ileocæcal valve, a cystic tumour the size of a man's fist. There was no communication with the bowel. Kulenkampff states that the case was of the same nature as Roth's.

Nasse[45] reports a cyst in the small intestine the size of an egg, 80 cm. from the cæcum. It projected into the mesentery and into the lumen of the gut, which was completely interrupted, ending blindly proximally and distally to the cyst. The cyst was lined with tall columnar epithelium; there were several goblet cells.

Tiedmann's[46] case (1813), referred to by Roth, was a pear-shaped cyst situated at the umbilicus and attached by a long pedicle to the convex border of the intestine. There can be little doubt that this was a Meckel's diverticulum.

Quesnel[47] reported four cases. The first was found in a newborn child. This was a cyst 3 cm. long in the submucosa on the antimesenteric wall of the ileum, near the cæcum. There was no communication with the gut lumen. Section showed two layers of muscle, and an atrophied mucosa with here and there columnar epithelium and glands. In his second case, a female child 4 months old who died of pneumonia, there was a similar cyst of the same size, near the cæcum, not communicating with the gut lumen. The wall showed on section a mucosa with columnar and goblet cells, glands, and two layers of muscle. His third case occurred in a female, age 62, who was operated upon for intestinal obstruction. The cyst was situated between the two muscular coats of the ileum in the antimesenteric wall, 57 cm. above the ileocæcal valve. It was composed of two parts, a smaller portion towards

the bowel lumen, and a larger cystic portion away from the lumen. The solid portion showed the structure of a spindle-celled sarcoma. Quesnel's fourth case is peculiarly interesting in that the mucosa of both cyst and adjoining intestine was tuberculous. The cyst, which showed the structure of the small intestine, was quite shut off from the lumen of the gut.

Hedinger,[48] in a post-mortem on a boy 5 years old, found a cystic tumour extending from symphysis to umbilicus and from one iliac crest to the other. It contained a litre of milky fluid. It was attached to the mesentery of the ileum 4 cm. from the root of the mesentery, 10 cm. from the ileocæcal valve. There was no communication with the intestinal canal. Section showed a peritoneal coat, two muscular layers, a muscularis mucosæ, and an epithelial lining; this lining in some places showed cylindrical epithelium, in most places flattened epithelium, and in some situations was devoid of any epithelial element. There can be no doubt that this cyst properly belongs to the group of developmental enterogenous cysts.

ILEOCÆCAL REGION.

Many cysts of intestinal structure have been discovered in this region and have been described as 'ileocæcal cysts'. They may occur in any part of the cæcum, at the ileocæcal junction, or in the adjacent ileum. They may project into the lumen of the gut, being sessile or pedunculated. They may be situated beneath the peritoneum, on the mesenteric or on the anti-
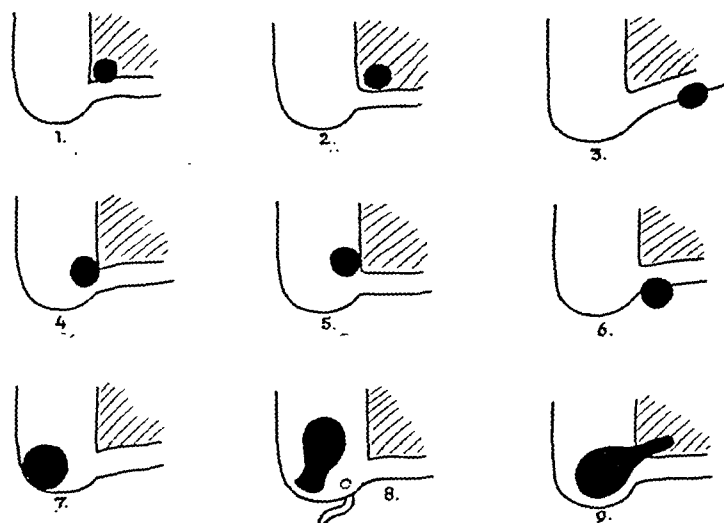
Fig. 45.—Position of developmental enterogenous cysts occurring in the ileocæcal region; the so-called 'ileocæcal cysts'. 1, Bolton and Lawrence; 2, Sir Arthur Keith, Turner and Tipping; 3, Neupert; 4, MacAuley, Hueter; 5, Sainsbury, Bazin; 6, Quesnel; 7, Blackadder, Girling Ball, Edwards; 8, Evans; 9, Ayer.

mesenteric border of the gut. They may be situated within the mesentery, unattached to the gut. These cysts differ in no respect from those we have described as occurring in the duodenum, jejunum, or ileum; they are developmental enterogenous cysts. The different positions in which they have been found are indicated in *Fig. 45.*

Sainsbury[49] described a cyst which he found post mortem in the first part of the ascending colon. The ileocæcal valve was situated below and somewhat behind the base of the attachment of the tumour (*Fig.* 45 5). The cyst was about the size of a duck's egg. Externally it was covered by a mucous membrane similar to that which lined the large intestine. The inner layer presented the structure of a serous membrane. In places a distinct muscular coat was present. From its position and the muscular fibres in its wall, I consider that this is a case of developmental enterogenous cyst.

Ayer[50] found the lumen of the cæcum occupied by a cyst as large as a duck's egg. It was sessile over about one-fifth of its surface, that portion being attached to the mesocolic border. At the site of attachment there was a funnel-shaped pocket extending for about two inches between the layers of the mesentery of the ileum, and just large enough to admit easily the examining finger. No microscopical examination was made of the cyst wall, but I have no doubt this was a congenital intestinal cyst projecting both into the lumen of the gut and between the layers of the mesentery (*Fig.* 45 9).

Fehleissen[51] reported a multilocular cyst containing 8200 c.c. of clear reddish fluid. There were three layers in the wall : an outer of dense connective tissue ; a middle of very vascular connective tissue, loosely arranged ; and an inner of unstriped muscle fibres arranged longitudinally, but with large bundles having a more or less irregular distribution. Fehleissen says, " the muscle fibres were characteristic ; they differed in no respect from those found in the intestinal tract or in the bladder wall." (*See also* Conant[52], Baldwin[53], and Bolton and Lawrence[54].)

Hueter's[55] case is interesting in that it was situated under the mucosa at the ileocæcal valve (*Fig.* 45 4). It was the size of a cherry-stone. It was lined with cylindrical cells and goblet cells, outside of which was a layer of lymphoid cells (*Fig.* 46).

Sprengel's[56] case occurred in a female, 15 years old, on whom a laparotomy was performed for suspected tuberculous peritonitis. The cæcum was resected for a tumour in that region. A cyst 3 cm. long was found on the ' left side ' of the ileocæcal valve, subserous. It had no communication with the lumen of the gut. Microscopical examination showed columnar epithelium, tubular glands, lymphoid tissue, and a few muscular fibres.

Blackadder[57] reported a cyst of the cæcum in an infant 10 weeks old (*Fig.* 45 7). Microscopical examination showed the surface of the tumour projecting into the lumen of the cæcum covered with mucous membrane similar to that of the intestine ; the cyst was lined with a somewhat stretched layer of columnar epithelium, which, however, in some places was folded into gland formation. Beneath each surface of epithelium was a submucosa infiltrated with leucocytes, and between these again were three more or less distinct layers of muscle.

Neupert[58] reported the case of a boy 10 years of age admitted into hospital with a painful circumscribed swelling in the ileocæcal region. On opening the abdomen a tumour about the size of a hen's egg was found in the ileum 10 cm. from the ileocæcal valve. The tumour occupied the antimesenteric side of the bowel (*Fig.* 45 3). Microscopical sections of the wall showed a lining of cubical epithelium with traces of a submucosa.

Externally and internally the cyst was enclosed by the muscular layer of the intestinal wall.

Turner and Tipping[59] reported the following case: A tense cyst about one inch in diameter was found in the mesentery, in the angle between the ileum and the colon (*Fig.* 45 2). It bulged into both these portions of intestine, causing obstruction at the ileocæcal valve. An attempt was made to remove the cyst, but although it was easily separated from the mesentery
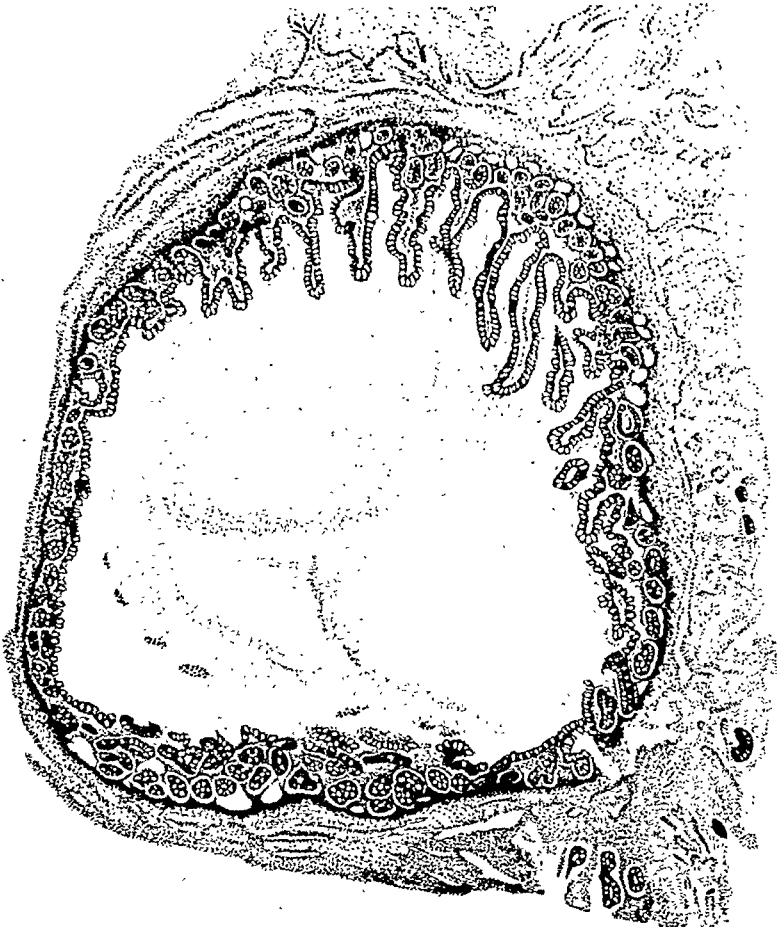
FIG. 46.—Developmental enterogenous cyst situated under the mucosa of the ileum, near the ileocæcal valve. (*From ' Zeigler's Beiträge*", 1896, xix, 391.)

its walls appeared to be absolutely incorporated with the wall of the ileum and the cæcum. As it seemed that a further attempt at removal would result in damage to the bowel, the cyst was incised and a quantity of white, odourless, glairy fluid was evacuated. There was no communication between the cavity of the cyst and the bowel. The greater part of the cyst wall was cut away and the edges were sewn to the parietal peritoneum. Mucoid material discharged from the wound for some time, but this eventually healed. Since

then on two occasions incisions have been required to allow of the escape of mucoid material which has collected in the cavity. A section of the cyst wall showed a structure closely resembling small intestine.

MacAuley[60] reported a case of a baby girl, age 6 months, operated upon for intussusception. The intussusception having been reduced, a tumour could be palpated in the cæcum at the site of the ileocæcal valve (*Fig.* 45 4). The ileocæcal region was resected, and is now in the Museum of the Royal College of Surgeons (Specimen 548.63).

Girling Ball[61] reported a case very similar to mine (*Fig.* 45 7).

Lotheissen[62] found in a female, age 21, a large cystic swelling in the interior of the cæcum (*Fig.* 47.) He attempted to enucleate the cyst by incising down the tænia, but failing, he resected the ileocæcal region and performed a lateral anastomosis with the transverse colon. This case is almost identical with my own (*Fig.* 45 8).

Bazin[63] reported a case of mucous cyst of the cæcum. After reduction of an ileocæcal intussusception, a hard mass still persisted, situated on the inside of the medial wall of the cæcum just above the ileocæcal valve (*Fig.* 45 5). " Microscopical examination of the cyst wall showed its outer layers consisted of mucosa, submucosa, and two muscle layers, all comparable to that found in the adjoining cæcum; its inner layers were composed of a fragmentary layer of muscle lined by a single layer of cuboidal cells."

FIG. 47.—Developmental enterogenous cyst in the cæcum. (*After Lotheissen,* ' *Deutsche Zeitschrift für Chirurgie* ', 1925, 179.)

In the Royal College of Surgeons Museum, Specimen No. 1221.1 is " a spherical retroperitoneal cyst 4 in. in diameter, intimately connected with the lower end of the ascending colon. Histologically the wall of the cyst consists of fibrous tissue with intermingled unstriped muscle fibres, lined with well-developed mucus-secreting epithelium ; here and there the surface raised into low papillæ."

Another specimen in the Royal College of Surgeons Museum (No. E. 16. A) is a cyst removed by Mr. Harold Edwards.[64] The patient was a girl, age 12, who suffered from symptoms resembling those of acute appendicitis. On opening the abdomen a mass was discovered in the right wall of the cæcum just below the level of the ileocæcal valve (*Fig.* 45 7). The mass proved to be a cyst in the cæcal wall. The cyst measured $3\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{3}{8}$ in. The wall contained a narrow band of circular muscle fibres and a submucous layer, and was lined by a single layer of low columnar epithelium.

VITELLO-INTESTINAL TRACT.

At the beginning of the fourth week of intra-uterine life the midgut is in wide communication with the yolk-sac. By the end of the fourth week the midgut has become tubular, and its communication with the yolk-sac has become tubular, forming the vitello-intestinal duct. Coursing over this duct

and the yolk-sac is the artery of the yolk-sac—the continuation of the superior mesenteric artery. In the sixth week the vitello-intestinal duct and the vessels accompanying it atrophy. The yolk-sac, by the constriction of the umbilical orifice and formation of the cord, comes to lie on the placenta, where a remnant of it may be found at birth near the implantation of the cord.

Meckel,[65] describing the anomalies of the abdominal portion of the alimentary canal, says : " The special deviations of primitive formation in the intestinal canal are :—

" *a*. The prolapsus of this canal into the umbilical sheath in a case of exomphalos. Instances of this anomaly are most frequent in the small intestine, as, when the development is normal, this portion of the canal enters last into the abdomen.

" *b*. The more or less perfect continuance of its primitive connection with the umbilical vesicle. This anomaly exists in several different degrees. Sometimes the umbilical vesicle continues beyond the usual time, and communicates with the ileon by an open canal which the omphalo-mesenteric vessels attend. Sometimes only a canal exists ; it varies in length, and extends from the same point of the ileon to the umbilicus, where it opens, and the omphalo-mesenteric vessels also accompany it.

" *c*. Finally, sometimes a greater or less prominence exists in this place, a prolongation termed the *diverticulum of the ileon*. This is often accompanied by the omphalo-mesenteric vessels, which float loosely at its extremity, which are attached to the umbilicus or to another region of the intestinal canal, so as to form a plexus." (" Quite recently I found them in a child of three months, arising, as usual, from the superior mesenteric artery and vein, running along the entire length of the diverticulum, and converted at its end into a solid thread, several inches long and hanging free."[66])

" These three anomalies are only different degrees of the same deviation of formation. This is proved by their appearing always in the same place, by their connections with the omphalo-mesenteric vessels, and, finally, by the fact that they always have the character of a primitive formation. That they depend on a primitive formation is proved by the facts that they are always observed in the same place, that they are formed by all the membranes of the intestinal canal, and that they exist simultaneously with other primitive deviations of formation, which arise from the development being arrested, or which, at least, favour their productions. All these circumstances united demonstrate that it is impossible to regard them purely as accidental productions, excrescences, contractions or hernias of the ileon."

Meckel notes the fact that in addition to diverticula whose existence was due to persistence of the vitello-intestinal tract (and which he called ' true ' diverticula) there were others whose existence could not be so explained— these he called ' false ' diverticula. " The false diverticulum differs from the true diverticulum [i.e., Meckel's diverticulum] by its rounded form, by the absence of several superimposed tunics, and, finally, by its occurring in every part, even in the stomach, but most frequently in the duodenum, and by the existence of several at once." Meckel considered that these were dependent upon solutions of continuity in the gut wall, resulting either from mechanical influence as the action of a cutting instrument, a rupture, or from a previous

alteration of texture as from ulcerations. "These solutions of continuity are sometimes complete, and then affect all the tunics; sometimes confined only to the muscular and peritoneal membranes, whence results a hernia of the inner membrane, and the formation of a rounded tumour termed a false diverticulum (div. spurium)."

Meckel, then, recognized two classes of diverticula: (1) Those derived from the vitello-intestinal tract; (2) Those not derived from the vitello-intestinal tract, which he called 'false'. By 'false' he undoubtedly meant any diverticulum not derived from the vitello-intestinal tract; and he considered all these were dependent on 'solutions of continuity'—either traumatic or from alterations in structure, e.g., inflammations—and that in all of them there was an 'absence of several superimposed layers'. We now know that some of these diverticula in stomach, duodenum, and elsewhere are not dependent upon trauma or any inflammatory process, and have no 'solution of continuity' in their coats; they are developmental in origin. But, as Meckel's 'true' diverticula were those, and those only, which were derived from the vitello-intestinal tract, it followed that these developmental enterogenous diverticula were grouped together with those which were obviously 'acquired', and to which alone the term 'false' or 'spurious' might fitly be applied. Because of this imperfect grouping one has repeatedly noted confusion in the description of cases recorded since Meckel's time. Thus, a diverticulum whose walls faithfully repeated the structure of normal gut has been
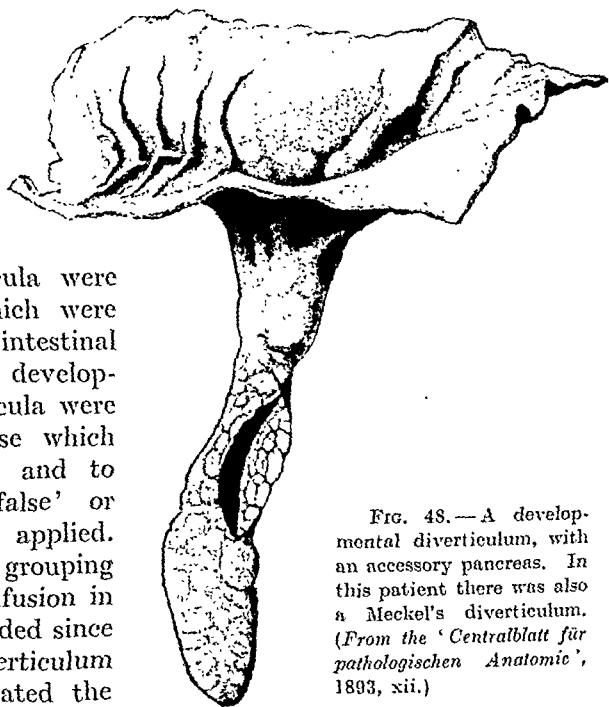
Fig. 48.—A developmental diverticulum, with an accessory pancreas. In this patient there was also a Meckel's diverticulum. (*From the 'Centralblatt für pathologischen Anatomie'*, 1893, xii.)

assumed *ipso facto* to have originated in the vitello-intestinal tract, irrespective of the portion of gut from which that *diverticulum arose* (including even diverticula of the œsophagus); and a diverticulum not originating in the vitello-intestinal tract has been assumed to be 'false', and therefore 'acquired'. Conclusive proof that the vitello-intestinal tract is not the only possible source of a developmental intestinal *diverticulum is afforded by* those cases in which more than one such diverticulum has been found.

Nauwerck[67] reported the occurrence, in a man, 43 years old, of a diverticulum 2·3 in. above the ileocæcal valve. This was of the thickness of a lead pencil and 9 cm. long; it arose from the free border of the gut. Attached to its tip there was found an accessory pancreas (*Fig.* 48). This, said Nauwerck, so closely resembled the case described by Zenker that he would have

considered it to be a Meckel's diverticulum with an accessory pancreas—had it not been for the fact that 80 cm. above the ileocæcal valve he found a typical Meckel's diverticulum 3 cm. long. Zenker's[68] case, to which Nauwerck referred, was that of a Meckel's diverticulum 54 cm. above the ileocæcal valve. This was 5½ cm. long. It possessed a small fat mesentery. In this mesentery near the tip of the appendix was an accessory pancreas the size of a cherry.
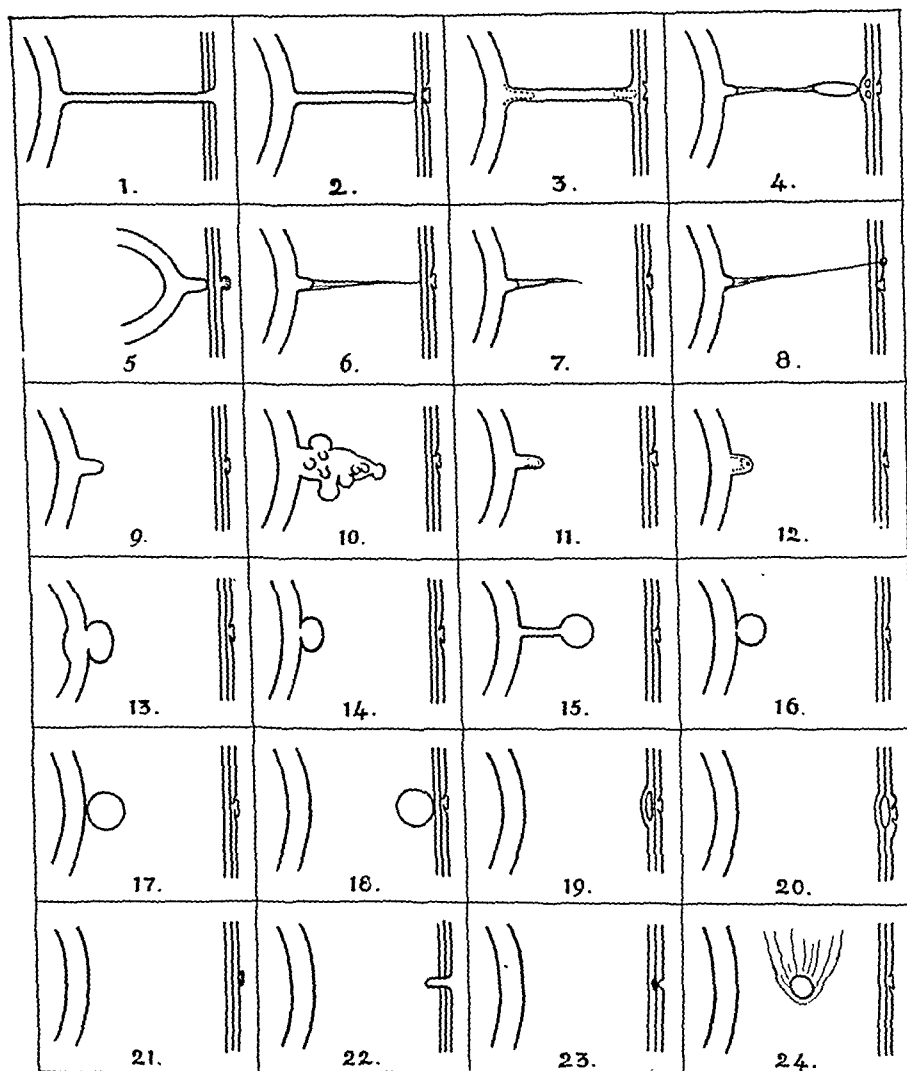
FIG. 49.—Anomalies dependent upon incomplete obliteration of the vitello-intestinal tract. The numbers correspond to those of the 24 cases cited in the text.

Roth[17] reported a case in which there was a cyst lined by gut epithelium in the thorax and another connected with the third portion of the duodenum ; also a diverticulum of the ileum lying between the layers of the mesentery, and at its extremity a gut-lined cyst (see Fig. 36). In this case there must have been three diverticula from the primitive intestinal tract.

The proper classification of intestinal diverticula is : (1) Developmental : (a) Those consequent on failure in the obliteration of the vitello-intestinal tract (Meckel's diverticula) ; (b) Those consequent on the persistence of the diverticula which normally occur in the fœtal entoderm. (2) Acquired.

Although the anomaly most commonly associated with imperfect obliteration of the vitello-intestinal tract is the persistence of its intestinal attachment (i.e., Meckel's diverticulum), it should be noted that any portion of this tract may persist, either within the abdominal cavity, or in its passage through the abdominal wall. It should also be noted that any portion of this tract may show heterotopic differentiation. Fig. 49 indicates these various developmental anomalies, and illustrative cases follow, the numbers corresponding to the numbers of the diagrams in the figure.

1. F. W. King[69] reports a case in a boy, age 14 months. Ever since the funis came off, on the 11th day after birth, he is stated to have had a discharge from the umbilicus of a thin yellow colour, and of a faint odour. There was no doubt that the sinus communicated with the small intestines. This was later proved at a post-mortem examination. The diverticulum, about 3 in. long, was found adhering to the umbilicus, and an adventitious cord appears to have compressed the ileum just below its connection with the diverticulum.

2. Hilton Fagge[70] quotes a post-mortem by Dr. Wilks on a girl of 10 who died of peritonitis. A Meckel's diverticulum was found about 15 in. above the cæcum. This was attached to the abdominal wall in the region of the umbilicus. It was pervious as far as the umbilicus, where it terminated in a blind end. It would admit an ordinary lead pencil.

3. Barron[71] at an autopsy found a narrow Meckel's diverticulum possessing a thick cord-like attachment to the abdominal wall in the region of the umbilicus. The umbilicus itself appeared normal. The proximal cavity was lined by mucosa exactly resembling that of the small intestine. In the apparently solid portion of the cord-like prolongation was a small cavity, 2·5 cm. by 2 mm., separated from the proximal diverticulum by a thin connective-tissue septum. This narrow cyst was lined by gastric mucosa.

4. Wilkie[72] operated on a boy, age 15, for acute intestinal obstruction. He found, about a foot from the ileocæcal valve, a tense sausage-shaped cystic swelling ; this was attached by a broad and twisted pedicle to the ileum, and its other end was moored to the abdominal wall at the level of the umbilicus. At the point of attachment to the ileum it had, by its torsion, caused an acute kink, with complete obstruction of the intestinal lumen. On excising the cyst, two other sessile cysts could be felt in the abdominal wall in the region of the umbilicus. " They evidently represented remnants of the omphalomesenteric duct in the abdominal wall, which had developed into separate cysts."

5. Cullen[73] reported a case of an umbilical polyp associated with a Meckel's diverticulum (Fig. 50). As Cullen says, " this case came within an ace of being one of patent omphalo-mesenteric duct."

6. Falk[74] found in a man, 20 years of age, a diverticulum 4½ in. long, two feet above the ileocæcal valve ; a solid pseudomembranous ligament 1½ in. long ran from its apex to the abdominal wall an inch from the umbilicus. A

band which united the diverticulum and the mesentery had given rise to intestinal obstruction.

7. Meckel's[66] case, to which reference has already been made. The vitelline vessels form a cord hanging free.

8. Taylor[75] reports a case of Meckel's diverticulum 4 in. long, from the apex of which a fibrous band passed to the abdominal wall behind the umbilicus. In the superficial tissues of the umbilicus was a small hard reddish nodule the size of a pea, visible and palpable on the suface. Microscopically, the apex of the diverticulum was seen to be lined by mucous membrane identical with that of the gastric fundus. The umbilical nodule, covered by normal squamous

Fig. 50. — An elliptical incision including the umbilical polyp has been made and the umbilicus lifted well away from the abdominal wall. Passing off from the loop of small bowel is a Meckel's diverticulum. This is firmly fixed to the inner surface of the umbilicus. Firmly attached to the outer surface of the umbilicus is the umbilical polyp. A small hole on the surface of the polyp, into which a probe can be passed for 8 mm., is the remnant of the lumen which formerly was continuous with Meckel's diverticulum. The omphalo-mesenteric artery and vein still persist. The polypus is covered by mucosa typical of the small intestine. (*From 'Surgery, Gynecology and Obstetrics'*, 1922, xxxv.)

epithelium, was composed of fibrous tissue in which no heterotopic tissue was seen. It was continuous with the fibrous band running to the apex of the diverticulum.

9. This represents the classical Meckel's diverticulum.

10. A Meckel's diverticulum may possess one or more nodular projections ; this one, removed by Mr. Rock Carling, has nine such accessory diverticula. (Westminster Hospital Museum, No. 525C.)

11. Taylor[75] reported 5 cases of Meckel's diverticulum at the apex of each of which the mucosa faithfully reproduced the structure of gastric mucosa.

12. In three of the cases of Taylor just mentioned, the superficial heterotopia were associated with deep heterotopia in the shape of aberrant pancreatic tissue.

13. A loop of ileum with an enormous Meckel's diverticulum (*Fig.* 51). The sac held 845 c.c. ; it is sessile on the gut, with which it communicates by a very wide opening. (R.C.S. Museum, No. 548.W.)

14. A large ovoidal Meckel's diverticulum, 4 in. in its chief diameter. Removed by Sir Charters Symonds. (R.C.S. Museum, No. 548X.)

15. Meckel's diverticulum in the form of a large pedunculated cystic swelling. (*See* Roth's case, p. 55 and *Fig.* 39.)

16. Struthers[76] reported a case of death from peritonitis due to leakage from a rounded swelling which was attached by a broad base to the upper
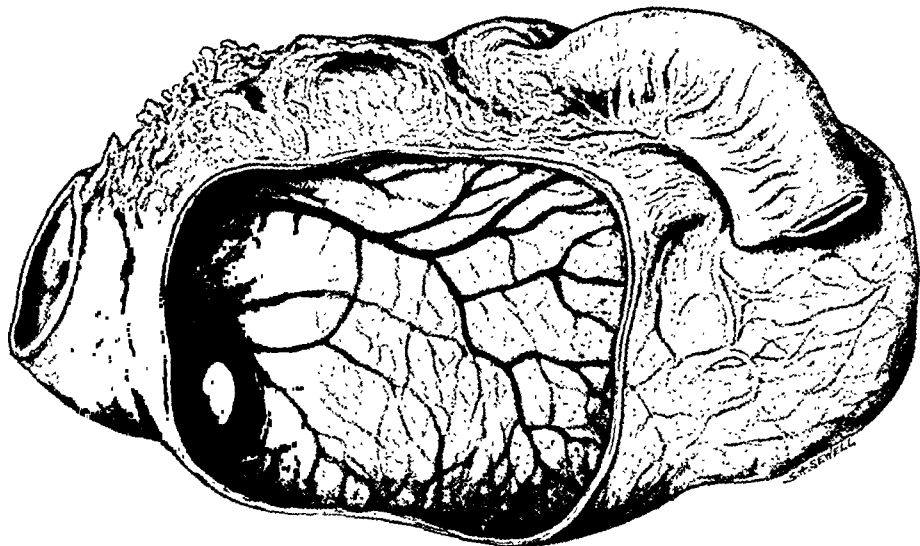
FIG. 51.—Persistence of wide communication between the mid-gut and the vitello-intestinal tract. (*R.C.S. Museum*, No. 548.W.)

aspect of the mesentery two feet above the ileocæcal valve, and lying up against the small intestine. Section showed this to be a thick-walled cyst which communicated with the lumen of the adjacent gut by a minute canal (*Fig.* 52). The interior of the cyst and of the canal were lined by columnar epithelium ; and the walls were composed of two layers of muscle fibres, longitudinal and circular.

17. Meckel's diverticulum forming a cyst, sessile on the gut, but having no communication with it. (*See* Räsfeld's case, p. 73 and *Fig.* 56.)

18. Schaad[77] found in the abdomen of a woman, age 33, a cystic tumour attached to the abdominal wall two finger-breadths below the umbilicus. It communicated with a smaller cyst. In the cyst was a chocolate-coloured fluid containing cholesterol. The cyst was lined with normal intestinal mucosa.

FIG. 52.—Meckel's diverticulum forming a thick-walled cyst, communicating with the gut by a minute canal. (*From the 'Edinburgh Medical Journal'*, vii, No. 4.)

19. Wyss[78] reported a cyst of the abdominal wall, ¾ in. above the umbilicus. It was the size of a bean, and lay between the muscle and the

peritoneum. The cyst contained a turbid mucoid fluid. In this fluid was a great number of cylindrical ciliated epithelial cells. The wall consisted of connective tissue with numerous fine elastic fibres. The inner lining was a continuous layer of ciliated epithelium.

20. Colmers[79] reports a case occurring in a woman, age 46, in whom he found a cyst the size of a small hen's egg attached to the parietal peritoneum, near the umbilicus. This cyst lay between the parietal peritoneum and the sheath of the rectus muscle, to which it was firmly adherent by a broad base. Below this, but not attached to it, was a smaller tumour the size of a hazel-nut ; this, too, was adherent to the abdominal wall. It terminated in a short firm cord-like band which opened into the umbilicus. This band on section showed the structure of the remains of the omphalo-mesenteric vessels (*Fig. 53*), in which will be observed two patent vessels, containing blood and each surrounded by unstriped muscle fibres. The walls of the cysts are composed mainly of connective tissue, in which there is marked calcareous degeneration. No epithelial lining could be demonstrated inside the larger or the smaller cyst, but the inner lining of the larger cyst consisted of a narrow layer of necrotic tissue. At the base of the larger cyst and communicating with it by fine openings were two prolongations. These are lined by very tall cylindrical epithelium very like Lieberkühn's glands ; here and there villi project into the lumen (*Fig. 54*). This layer rests on a muscularis mucosæ ; then follow unstriped muscle fibres, which, although not arranged into two layers as regularly as that found in the gut wall, yet can readily be differentiated into circular and longitudinal fibres.

21. Stone[80] collected 38 cases of umbilical polypus, 34 of which were composed of normal intestinal epithelium ; 4 were composed of gastric mucosa. In 3 of the cases reported by A. L. Taylor, two were covered entirely with mucosa of intestinal type, one with gastric mucosa. Taylor refers to a case reported by Tillmanns in a boy of 13 : a pedunculated tumour, the size of a walnut, increased in size after each meal, and in the course of a few minutes secreted 2 to 3 c.c. of clear fluid identical with gastric juice.

Many instances have been recorded in which vestiges of the vitello-intestinal tract at the umbilicus have shown heterotopic differentiation. Nicholson says : " Pyloric glands have been recorded in an umbilical polypus by Tillmans. Cardiac glands were found in the umbilical part of a patent vitelline duct by Salzer, and at the apex of a Meckel's diverticulum by Meulengracht. Brunner's glands are described by Kern in the extroverted distal end of a patent duct, and by Tschiknawerow at the apex of a Meckel's diverticulum. Wright found a small encapsulated pancreas in the subcutaneous tissue of the umbilicus of a girl of 12." The diversity of epithelial structure found in this situation is accounted for by the fact that in the early stage of development the vitelline duct was almost as wide as the whole of the primitive gut ; so that there is no reason to suppose that the epithelium of the vitelline duct does not share all the prospective potentialities of the primitive gut.

22. Roser[81] reports a case in a man who had been operated upon for a tumour in the region of the umbilicus. A fistula persisted, and from this there was a slimy watery discharge. On examination it was found to pass into a cavity about 6 cm. in diameter. As much as possible of the lining
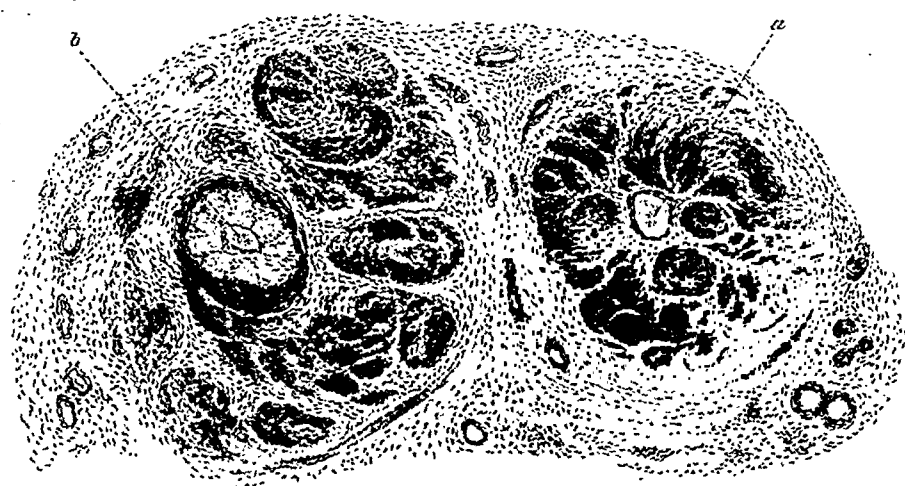
FIG. 53.—Section of fibrous band connecting cyst to umbilicus. *a* and *b* are the remains of the omphalo-mesenteric vessels, each containing blood and surrounded by unstriped muscle fibres. (*From Colmers, 'Archiv für klinische Chirurgie', 1906, lxxix.*)
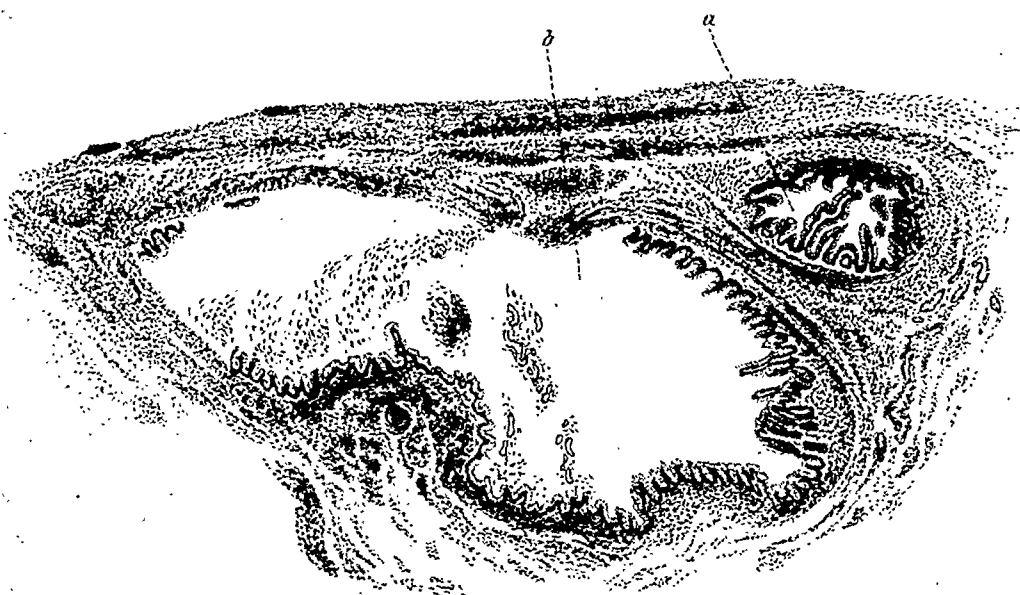
FIG. 54.—Same case as *Fig.* 53. Two prolongations (*a* and *b*) from a cyst near the umbilicus. Each is lined by tall cylindrical epithelium; villi project into the lumen. This layer rests on a muscularis mucosæ; and this on circular and longitudinal unstriped muscle fibres. (*From Colmers, 'Archiv für klinische Chirurgie', 1906, lxxix.*)

was dissected out. The mucous lining was found to contain Lieberkühn's glands.

23. John H. Wright[82] reports in a female child, 12 years old, the occurrence of an umbilical fistula which had been present since birth. A. T. Cabot dissected this out, down to the level of the peritoneum. The peritoneal cavity was opened and explored ; no connection of the fistula with the intestine could be made out. Microscopical examination showed " that the specimen for the most part consisted of dense connective tissue together with some fat tissue. The fistulous tract appeared to correspond to an invagination of the epidermis. In the midst of the substance of the specimen, at a point about 2 mm. from the apex of the invagination of the epidermis, an irregularly-shaped nodule, $3\frac{1}{2}$ mm. in greatest diameter, was found. Microscopical examination of this nodule showed the structure of pancreas. Amongst the tubules were undoubted islands of Langerhans.

24. In a case recently operated upon at Westminster Hospital by Mr. Stanford Cade, for the radical cure of an inguinal hernia, the vermiform appendix was found occupying the sac. The appendix was removed. Exploration of the neighbouring peritoneal cavity revealed a small tumour in the great omentum (*Fig.* 55). This was excised. It proved to be a cyst lined by a layer of columnar ciliated epithelium ; outside this were a muscularis mucosæ, a layer of connective tissue, and several layers of muscular fibres—some cut longitudinally, and others transversely. This is certainly a developmental enterogenous cyst. It may have been derived from the vitello-intestinal tract, have become completely detached from the parent gut, and grafted on to the omentum. (Cf. Struther's case, p. 70 and *Fig.* 52, and Roth's case, p. 55 and *Fig.* 39.)
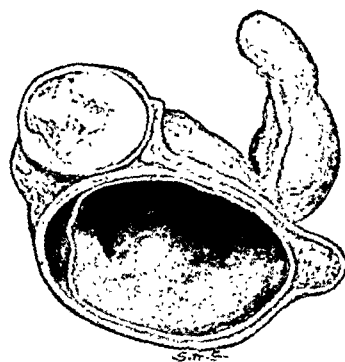
FIG. 55.—A developmental enterogenous cyst, situated in the great omentum. This may have been derived from the vitello-intestinal tract. (× 2.)

Räsfeld,[83] in his work on Meckel's diverticulum, noted this change from diverticulum to cyst so clearly that I quote a few of his sentences and copy his diagram (*Fig.* 56). " Rarissime fit ut latus intestini, in quo diverticulum inhæret, claudatur, diverticulum autem ipsum, partim modo evanescat, ita ut in cystæ formam in ileo insedeat."
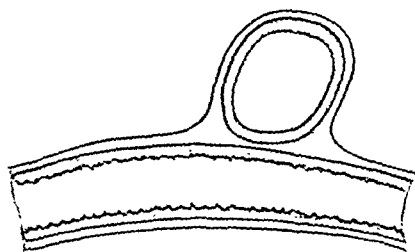
FIG. 56.—Medium sectum diverticuli, in formam cystæ, 10" a valvula colli, in puellæ neonatæ, omnino bene formatæ, ileo, infixi, quod peritonaeo arcte circumclusum. iisdem membranis constabat, quibus intestina ; muco perspicuo erat impletum. (*After Räsfeld*, ' *De Hernia Littrica Berol* ', 1852, 11.)

Fitz[84] describes a specimen in the Warren Museum (No. 4903) found at the autopsy of a patient who died of chronic pleurisy. About one metre above the ileocæcal valve was a cyst of Meckel's diverticulum. 3 cm. in length and about 1 cm. in diameter. No communication could be found between it and the lumen of the intestine.

VERMIFORM APPENDIX.

Hedinger[85] described an autopsy on a child who died at birth, death being consequent on protracted labour due to hydramnios and transverse presentation. A small umbilical hernia contained a piece of large intestine and the vermiform appendix, the distal end of which was adherent to the hernial sac. The proximal portion of the appendix was normal; the distal
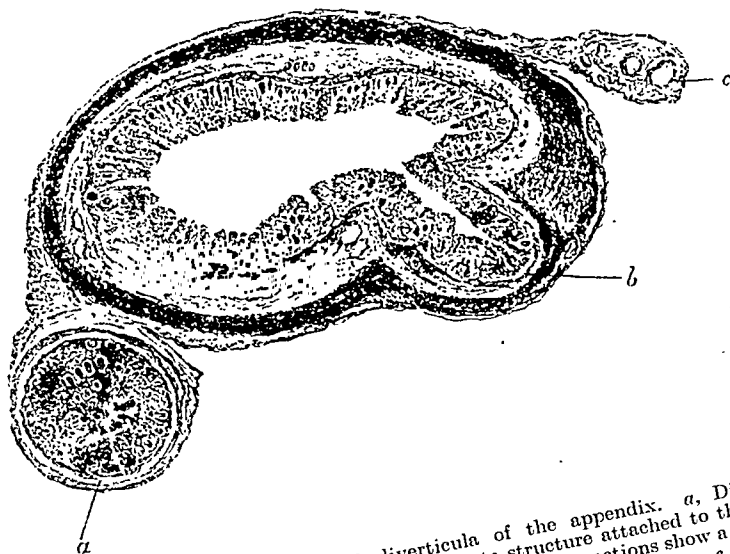
FIG. 57.—Multiple developmental diverticula of the appendix. a, Diverticulum of the appendix, appearing in this section as a separate structure attached to the appendix by serosa; a further section shows a common submucosa; other sections show a lumen common to a and to the appendix. b, Diverticulum extending to the muscular coat. c, Meso-appendix. (From 'Virchow's Archiv', clxxviii, Fig. 1, page 172.)

third was greatly diminished in size and of peculiar uneven surface, studded with small knobs of various sizes, all subserous. Microscopical examination revealed many congenital diverticula (Fig. 57). In addition to these there were in the submucosa many areas of mucosal structure showing greatly branched Lieberkühn's glands with tall cylindrical epithelium.

SIGMOID.

Garnett Wright[86] described a diverticulum 37 in. long which commenced at the upper end of the sigmoid loop of the colon (Fig. 58). It ran at an acute angle downwards and entered between the layers of the mesosigmoid. Here it occupied the cavity of the sigmoid colon, and became of a very large size, being much greater in diameter than the bowel. On reaching the end of the sigmoid loop the diverticulum separated from the colon, to which up to now it was intimately adherent, and narrowing abruptly, passed from between the layers of the meso-sigmoid to lie behind the posterior parietal peritoneum.
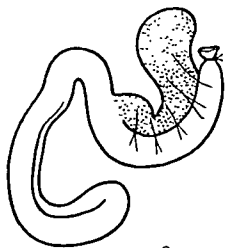
FIG. 58.
Garnett Wright's case.

Here it turned upwards and expanded into a blind sac, reaching a position on the posterior abdominal wall behind the stomach. In the recent state the circumference of this portion of the diverticulum was 17 in. The diverticulum possessed two muscular layers, an outer longitudinal and an inner circular. The inner coat of the diverticulum consisted of a mucous membrane thrown into irregular folds lined by epithelium of the usual large-intestine type.

'REDUPLICATIONS.'

I think there can be little doubt that many cases recorded as reduplications of portions of the intestinal tract were either developmental diverticula or enterogenous cysts.

Fairland,[87] operating to relieve intestinal obstruction in a child born with an imperforate anus, opened the abdomen, withdrew a distended portion of gut, and opened this; a large quantity of fæces rushed out. At the post-mortem examination it was found that the opening had been made into a large diverticulum (*Fig.* 59 c), 13 in. long, which arose from the duodenum about 1½ in. from the pylorus. In this case the gut was said to have 'bifurcated', but there can be little doubt that the second portion of gut was a developmental diverticulum.
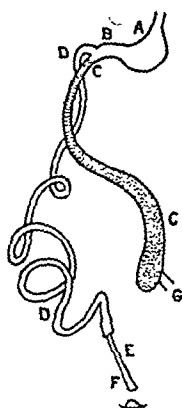
| Fig. 59.—Fairland's case. | Fig. 60 —Lockwood's case. | Fig. 61.—Meckel's case. |
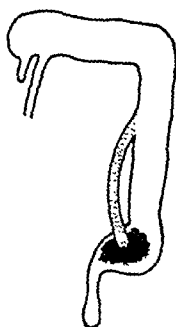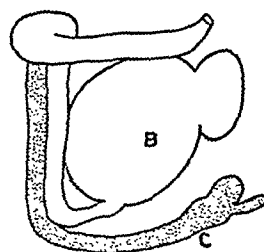
C. B. Lockwood[88] described the case of a man, age 57, who died of intestinal obstruction (*Fig.* 60). " At the post-mortem examination, the cæcum was found in the right hypochondriac region, beneath the liver. The colon crossed from the cæcum to the splenic curve, and thence descended into the pelvis. Here a remarkable abnormality occurred. The descending colon was double; the two tubes were upon the same plane, the smaller one nearer the vertebral column. Each possessed appendices epiploicæ. The tube which was nearest the spine had a very small canal in its centre, which appeared to have a mucous lining. This canal opened above into the colon by means of a small aperture; below, it was lost in a mass of malignant disease. It contained no fæces. Its walls were moderately thick. The malignant mass which received the end of the diverticulum also concealed the end of the outer tube, which was the colon proper. It is very hard to imagine how a tube which is at first single can afterwards become double. Meckel[89] has pictured the intestines of a fœtus in which there were two cæca (*Fig.* 61). The ileum

opened into B, and from it the gut extended upwards towards the hepatic curve. Below this cæcum was another, C, from which a tube extended parallel to and outside the first, and also continuous with the transverse colon, at the hepatic curve. Meckel[90] also figures a case in which the cæcum was bifid." Commenting on Lockwood's case, Dr. Symington, of Edinburgh, remarked that one of the two tubes in the position of the descending colon might be a diverticulum, there being no proof that they united below.

Fitz[91] recorded a case of "intra-mesenteric duplication of the intestine"

FIG. 62.—Fitz's case.

(*Fig.* 62). "Two more or less parallel intestinal tubes, cut transversely across in their continuity, are contained within a single mesentery. The blood-vessels of the latter terminate in the wall of the outermost tube, first supplying branches to the inner tube. The diameter of the outer tube is relatively uniform throughout, while that of the inner, in general somewhat narrower, becomes dilated in the immediate vicinity of an opening through which the canals of the tubes communicate with each other. The contiguous portions of the walls of the two tubes are in close proximity to each other throughout the greater part of their course, and are fused near the common opening. The walls are composed of mucous, muscular, and peritoneal coats. The mucous membrane of the outer tube shows slightly projecting transverse folds in the vicinity of the opening, while that of the inner tube is relatively smooth. Villi and crypts are present in both. The opening between the tubes is rounded, sharply defined, one-third of an inch in diameter, and appears to be covered by mucous membrane. The canal of the inner tube is contracted in the immediate vicinity of the opening, and its wall at this part is thickened and fibrous." I think this is a case of developmental enterogenous diverticulum which, on reaching the outer surface of the parent gut, extended orally and aborally. Unfortunately no record was made of the length of the diverticulum.
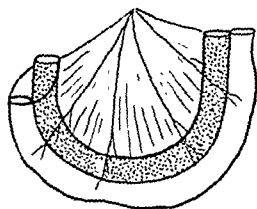
A glance at Roth's case (*Fig.* 63 ; *see also Fig.* 40), I think, enables one to understand more clearly the development of the case described by Fitz.

FIG. 63.—Roth's case.

In Roth's case we have an undoubted developmental diverticulum. This on reaching the serous surface of the parent gut extended aborally along it for a distance of 10 cm. Had it bifurcated at its commencement and extended orally as well as aborally the resulting condition would have been similar to that figured by Fitz.
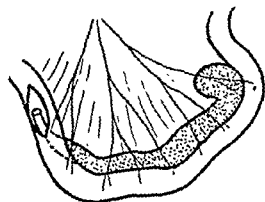
In the Royal College of Surgeons Museum, Specimen No. 1222.1 is "a piece of small intestine of an ox to one side of which there is intimately attached a long tubular cyst, 17 in. in length, and of the same calibre as the intestine itself; the groove between the two, on the free aspect, is filled with fat. At either end the cyst terminates blindly, and for a short distance is unconnected with the gut (*Figs.* 64 and 65). In the recent state the cavity was filled mainly with epithelium. Microscopical examination shows that the

cyst is furnished with a double muscular wall, and a mucosa with muscularis mucosæ, but without lymphatic tissue. The mucosa bears no villi or papillæ, and is invested with a stratified epithelium devoid of a stratum granulosum. The cyst has probably arisen in the omphalo-mesenteric duct, the original columnar epithelium of which has become transformed into the kind mentioned." I think, as in Fitz's case, this cyst originated in a develop-
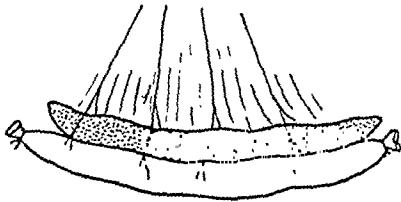
FIG. 64.—Specimen in R.C.S. Museum (No. 1222.1).

mental diverticulum, which, on gaining the surface of the parent gut, bifurcated and extended orally and aborally. That the two ends of the cyst are not connected with the gut confirms this suggested mode of origin.

Garnett Wright's case (*Fig.* 58) so closely resembles Roth's case that I think it should be assigned to the group of developmental enterogenous diverticula.

Pritchard's case, to which reference has already been made, is that of a second stomach situated behind the peritoneum. This, I consider, started as a developmental diverticulum from the fore-gut, which, becoming detached, formed an enterogenous cyst. The same origin must be ascribed to Ahrens' case in which, behind the peritoneum, was found a cyst which resembled an hour-glass stomach and 26 cm. of small intestine. Microscopical examination of the cyst wall revealed a structure identical with that of a stomach and of small intestine, save that the mucosa in different sections consisted of " stratified and cuboidal cells, stratified ciliated cells, tall columnar, and flat cells." These two cases well illustrate the potentialities of a small isolated portion of the fœtal entoderm. So, too, does the following description of the distal end of a vitello-intestinal tract.

FIG. 65.—A piece of small intestine of an ox, to one side of which there is intimately attached a long tubular cyst. ($\times \frac{1}{4}$.) (*R.C.S. Museum*, No. 1222.1.)

Nicholson[6] reports a specimen removed from a boy of 8. It consists of a narrow tube, about 2 cm. in length, the distal half of which is gradually dilated to form a funnel-shaped organ, which opened on to the base of the umbilicus without, as is frequently the case, having undergone eversion. The proximal end was attached to a coil of small intestine, identified as ileum.

" The mucous membrane of the proximal end of the duct is identical with that of the lower part of the small intestine.

" The widened distal end of the duct is lined by a highly differentiated and beautifully finished fundal mucous membrane. Where the duct becomes narrowed to pass into its intestinal portion the fundus is separated from the iliac mucous membrane by a narrow pylorus. This consists of masses of large coiled glands, whose efferent superficial segments pursue an irregular course between the fundal glands, to open upon the surface among them. The line of union between the gastric and intestinal epithelium upon the surface of the duct is sharp and abrupt. Pyloric glands extend for a short distance into the beginning of the intestinal mucous membrane. Here they occupy its deep surface beneath the crypts of Lieberkühn. They thus appear to correspond with Brunner's glands, although they do not penetrate the muscularis mucosæ. The last-named structure consists of a regular sheet of plain muscle fibres, which is thickened beneath the ring of pyloric glands to form a sphincter. A glance at *Fig.* 66 demonstrates the highly organized structure and morphological finish of this small ectopic stomach, with its broad fundus and its narrow pylorus. Not only is its structure perfect, but there is evidence that its physiological secretion was identical with that of the stomach."

FIG. 66.—Meckel's diverticulum 2 cm. long. The distal end, lined by fundal and pyloric mucosa. (*From the 'Journal of Pathology and Bacteriology'.* 1923, xxvi.)

Nicholson records another narrow Meckel's diverticulum, about 15 cm. in length. " The greater part of this is lined by a perfectly differentiated fundal mucous membrane, whose semi-digested condition proves the presence of a secretion analogous to the gastric juice."

EPITHELIAL MISPLACEMENTS.

Indirect evidence of the common occurrence and widespread distribution of fœtal diverticula is afforded by a study of the epithelial misplacements of the alimentary tract. The reader is referred to most illuminating writings on this subject by G. W. Nicholson[92] (" Heteromorphoses of the Alimentary Tract ") and by A. L. Taylor[57] (" Epithelial Heterotopias of the Alimentary Tract.")

Taylor, working with the material obtained in two years from the operation theatres and the post-mortem room of the Leeds General Infirmary, found 69

cases of epithelial misplacement in the intestinal epithelium. In a series of 81 cases reported by him, the type of epithelium misplaced and the situation in which it was found are shown in the following table :—

TYPE OF MISPLACED TISSUE	REGION AFFECTED	NO. OF CASES
1. Superficial heterotopia		
Œsophagus		6
	Duodenum	2
a. Gastric	Small intestine	1
	Meckel's diverticulum	5*
	Umbilicus	1
b. Intestinal	Stomach	36
	Umbilicus..	3†
c. Duodenal	Stomach	1
2. Deep heterotopia		
a. Submucous glands	Stomach	1
b. Intramural cysts	Stomach	1
c. Adenomyoma	Stomach	6
	Duodenum	3
	Stomach	6
d. Accessory pancreas	Duodenum	7
	Jejunum	3
	Meckel's diverticulum	3
	Total	81

* Includes the three cases in which heterotopic pancreas was also present.
† Includes the case showing gastric type heterotopia.

Seeing that 69 of these cases were obtained in two years from the operation theatre and the post-mortem room of the Leeds General Infirmary, it is safe to assume that if minute routine examination of the whole alimentary tract were the invariable rule, heteromorphoses of the intestinal tract would prove to be of fairly frequent occurrence.

Nicholson, in his studies of the heteromorphoses in the human body, says that " they can be all referred to anomalies of differentiation ; cell differentiation is, within wide limits at all events, the result of stimulation from without, of environment in fact. When this is normal, differentiation will inevitably be so too ; when cells are exposed to abnormal influences they will as inevitably undergo differentiation in an abnormal direction." " The entodermal cells lining any 'bud' from the primitive intestinal tract possess all the potencies of the gut of which they have barely ceased to form a part. But in the very process of budding their environment alters. They are thus forced to develop certain of their original potencies and to suppress others. By so doing the immediate environment—the stimuli, internal as well as external, to which these are subjected—is again altered. If the sequence of stimuli or changes of environment is orderly the cells will, in the fullness of time, acquire the structural characters of pancreatic tissue or of liver tissue. If it be interrupted and altered to an extent to which the cells can only respond by the development of some other of their original potencies, an abnormal or heterotopic tissue must result."

A specimen described by Lewis and Thyng illustrates this. They observed in a 41·6-mm. rabbit embryo a single diverticulum. It possessed an oval lumen which emptied into the intestine. It was lined with smooth epithelium, contrasting with the much enfolded intestinal layer which was in process of forming villi. These writers state : " It is well known that a small pancreas may develop at various places along the lumen of the small intestine. We have examined four such cases—one from the duodenum, two from the jejunum, and one from the umbilicus. The position of these structures accords with that of the early diverticula."

A. T. Lewis[93] says it is possible that accessory pancreases sometimes develop in relation with embryonic intestinal diverticula. In the embryo to which reference has already been made (see Fig. 23) it was noted that a small cyst, obviously derived as a diverticulum from the duodenum, was situated in the mesenchyme. In this same specimen was a diverticulum of the duodenum situated above the dorsal pancreas. Below the duct of the dorsal pancreas was another elongated, unbranched diverticulum 0·55 mm. long and about 0·07 mm. in diameter. This outgrowth had a distinct lumen, and was somewhat expanded at its distal extremity, where the cells were of the same nature as those of the other portions of the pancreas. In the small detached cyst, however, the epithelium of the cyst which corresponds with the accessory pancreas was quite unlike that of the pancreas. The pancreatic tubules, about 0·05 mm. in diameter, contained only a minute lumen, whereas the cyst had a cavity 0·22 mm. in diameter, equal to that of the intestine. Beyond the diverticulum with pancreas at its distal extremity there were eighteen diverticula along the anterior limb of the intestinal loop. In this single specimen we have nineteen simple diverticula of the intestinal wall, one elongated diverticulum containing pancreatic structure at its tip, and a cyst—derived from a diverticulum—the lining cells of which differed from the entoderm of the neighbouring intestine and from the pancreatic cells.

I think there can be no doubt that the cells lining developmental enterogenous diverticula and cysts are exposed to influences which differ from those to which the adjacent normally situated cells are exposed; hence they are likely to differentiate into cells which differ from those in their immediate vicinity.

The association of heterotopic tissue with diverticula has been frequently observed, and one is driven to the conclusion that such conditions as that which follows must have originated in the diverticula of the fœtal entoderm. A. L. Taylor[75] reported the case of a woman, age 52, who died of carcinoma of the rectum. On the posterior wall of the œsophagus at the level of the cricoid cartilage was a small whitish area about ⅜ in. long, one margin of which showed a definite break in the epithelium. Microscopically this is found to be the mouth of a small flattened diverticulum or pocket in the mucous membrane, with edges closely apposed to each other. This pocket is surrounded everywhere by a thick muscularis mucosæ, and does not protrude for any distance into the submucous tissues. Its walls are lined by gastric glands entirely of cardiac type, some of them much dilated and containing cell débris or secretory products. The transition from œsophagus to gastric epithelium takes place abruptly at the mouth of the diverticulum.

Taylor also described a small diverticulum on the posterior wall of the duodenum. The diverticulum, of irregular shape, was about ¼ in. across and directed obliquely towards the pylorus. The floor of the diverticulum was lined by gastric (fundal) mucous membrane, and beneath this the submucous glands were absent. Distal to this, and about ½ in. from the pylorus, was a small whitish patch. This, being microscoped, proved to be a patch of fundal glands lying in the duodenal mucosa. It was confined to the inner side of the muscularis mucosæ, beneath which the submucous layer was devoid of Brunner's glands.

We may hence conclude that apart from the enterogenous cysts which are derived from the vitello-intestinal tract, the cysts of similar structure which are found in the abdomen or in the thorax originated in the diverticula which are found in the fœtal entoderm, as described by Keibel and by Lewis and Thyng. Most of these diverticula disappear; some persist. Of those that persist, some become lined by epithelium which differs from the immediately adjacent epithelium and resembles that of some other portion of the intestinal tract: these are the superficial and deep heteromorphoses. Some develop into gross diverticula, and others into closed cysts: these are the developmental enterogenous diverticula and cysts. Such diverticula and cysts are usually lined by epithelium similar to that lining the adjacent gut, but occasionally they are the seat of superficial or deep, or of both superficial and deep, epithelial heteromorphoses.

SUMMARY.

The cyst here recorded, one of the group commonly designated 'ileocæcal cysts', is a developmental enterogenous cyst. All cysts found in the abdomen, or in the thorax, or at the umbilicus, having the structure of gut, must have been derived from the primitive intestinal tract; they are developmental enterogenous cysts.

These cysts originated either in the vitello-intestinal tract, or in the diverticula which are found in the developing entoderm of the embryo, as described by Keibel, and by Lewis and Thyng.

Some of these developmental diverticula persist as diverticula, and increase in size.

Instances are given of enterogenous cysts which originated in developmental diverticula situated in those segments of the primitive intestinal tract which later became œsophagus, stomach, duodenum, jejunum, ileum, ileocæcal region, vermiform appendix, or sigmoid; also of enterogenous cysts which originated in some unobliterated portion of the vitello-intestinal tract.

The great variety shown in the structure of the inner lining of these cysts is in some cases accounted for by intracystic pressure, in others by inflammatory changes, and in many by an error in differentiation of the lining cells resulting in heteromorphosis of the epithelium.

It is probable that all the epithelial misplacements of the intestinal tract, whether occurring in enterogenous cysts, in developmental diverticula, or as the superficial and deep heteromorphoses of the intestinal tract, originated in the diverticula which are found in the developing entoderm of the embryo.

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HÆMANGEIOMATOUS CYSTS OF THE CEREBELLUM.

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THAT cerebellar cysts frequently have a small knot of tumour in their walls has been known for half a century. In 1872 Hughlings Jackson[1] found in the wall of a cerebellar cyst a tumour, the size of a shilling on its cut surface, which extended to the surface of the cerebellum. He noted that the inner surface of the tumour protruded into the wall of the cyst without any covering by cyst wall. Since that time a large number of cases has been recorded in which cerebellar cysts have had a tumour in their walls. Many of these tumours have been called gliomas, and others angeiosarcomas on microscopic examination; but within recent years it has become clear that a large proportion are hæmangeiomas. This fact is of importance from a surgical point of view, for cerebellar hæmangeiomas are the most benign of intracranial growths, and the removal of such a tumour from the wall of a cyst should in most cases result in the cure of the patient.

In a recent monograph Lindau[2] has reviewed all the recorded cases of cerebellar cysts and has added to them a number of fresh cases, some recent, and some old specimens from museums in Scandinavia, Germany, and Czechoslovakia. He divides cerebellar cysts into six classes: (1) *Dermoid cysts and cholesteatomata*; (2) *Cysts formed as a result of hæmorrhage or softening*; (3) *Parasitic cysts*; (4) *Cysts in relation to a tumour*; (5) *Simple cysts*; (6) *Cysts in communication with the 4th ventricle*. To make the subject complete from a surgical standpoint we might add to these classes two forms of extracerebellar cyst, viz., cystic acoustic nerve tumours, and meningeal cysts caused by arachnoid adhesions. It is our present purpose to consider Lindau's Class 4, i.e., cysts in relation to a tumour, and to discuss whether his Class 5 exists, i.e., whether simple cysts may arise as a developmental anomaly apart from tumour growth.

It is quite impossible in reviewing the literature of cysts in relation to a tumour to say how many of these tumours are angeiomas and how many are gliomas. There is no doubt, however, that these two forms of growth are those most commonly responsible for intracerebellar cysts. It is not possible in many cases to distinguish with the naked eye between these two forms, nor is it possible in reviewing the literature to say how many of the recorded tumours should be allocated to either class. We might be tempted to accept the microscopical diagnosis attached to each tumour were it not for the fact that in some instances the histological appearance revealed by the illustrations is quite at variance with the diagnosis given. It is to be noted also that the term 'angeioma' does not appear in the literature of the subject until 1923. While we cannot say definitely that angeiomas are the commonest form of tumour in relation to cerebellar cysts, our own experience suggests that they are. In a recent paper Dandy[3] reports seven cases of angeiomatous cerebellar

cysts, and expresses the view that in his operative experience they occur about as frequently as gliomatous cysts of the cerebellum.

Lindau has found 16 angeiomas and 8 gliomas in relation to cerebellar cysts. Our collection at the National Hospital, Queen Square, since the year 1914, includes 7 angeiomatous cysts (one bilateral) and 2 gliomatous cysts. These figures suggest that angeiomatous cysts are at least twice as common as gliomatous cysts in the cerebellum. In addition, both Lindau and we ourselves have found solid rounded angeiomas occurring as multiple growths in relation to the cerebellum and pons. These tumours have an identical structure to those in the wall of cysts and must be considered along with them.

An interesting point which has been brought to light by Lindau in relation to angeiomas of the cerebellum is the frequency with which they are associated with angeiomas or angeiomatous cysts elsewhere in the body. Angeiomatosis of the retina was present in two of his cases,* and has been seen also by Cushing and Bailey[4] and by Seidel[10] in cases of cerebellar cysts.† In other cases angeiomas of the spinal cord or medulla, cysts of the pancreas, hypernephromas, cavernous angeioma of the liver, or cystic kidneys have been found in patients who have died as a result of angeiomatous cysts of the cerebellum. This combination of cystic tumour of the cerebellum with angeiomas or cysts in other organs clearly demonstrates the congenital nature of the tumours. We have not been able to confirm Lindau's observations in this matter, possibly owing to the partial nature of the post-mortem examination allowed in our cases. It may however be said definitely that in none of our seven cases was an angeioma of the retina visible on ophthalmoscopic examination.

CASE HISTORIES.

Case 1.—(This case was reported in *Brain*, 1919, as an atypical endothelioma.[5])

W. B., a soldier, age 31, was admitted to the National Hospital, Queen Square, in April, 1918. He had, for about six months, been feeling giddy, especially during the morning parades. For three months he had also had severe headaches and his sight had been failing. His speech had become of a staccato character. He gave a history that a brother and a sister had ' died of the same thing ' at the ages of 27 and 26.

On Examination.—Except for an unsteady gait, he presented very slight signs of cerebellar disease. There was no nystagmus, and his co-ordination was nearly perfect, but on alternate movements his right arm and leg were slightly clumsier than the left. There was no alteration of the reflexes or of sensibility. Lumbar puncture gave a clear fluid containing 0·15 per cent protein, but no cells. The Wassermann reaction was negative in the blood and cerebrospinal fluid. He became gradually worse, becoming subject to fainting fits, in one of which he died three months after admission.

Autopsy.—A post-mortem was made and the brain fixed in formalin before it was examined by us. On hemisection of the fixed brain in the sagittal plane, an irregularly shaped cavity was seen lined with a thick yellow membrane which was easily detachable from the brain substance. This cavity ran from the roof of the fourth ventricle up behind the mid-brain to the pineal body, from which it was separated by a layer of pia mater. As it passed downwards to the upper surface

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* In one it could only be seen on microscopical examination.

† A similar case in which the patient and two other members of his family suffered from angeiomatosis retinæ has been reported by Rochat (*Klin. Monatsbl. f. Augenheilk.*, 1927, lxxviii, 601).

of the cerebellum it became embedded 4 mm. below the surface. It passed rather higher on the left side of the brain-stem, reaching the left corpus geniculatum internum. On the right side it passed backwards and outwards into the upper part of the right cerebellar hemisphere. It presented four openings in the middle line and many divarications in the substance of the cerebellum. Its antero-posterior diameter was about 5 cm. and its transverse diameter 3·5 cm. A small rounded tumour was found in the left wall of this cyst. In addition there were two other tumours, one embedded in the cortex on the under surface of the cerebellum at the junction of the posterior end of the [inferior vermis with the left lateral lobe. This was a rounded reddish tumour, rather granular on its surface, and measuring 10 mm. It was surrounded on its upper surface by a small cystic space, the walls of which appeared to be formed of smooth, slightly reddened brain tissue. A similar much smaller tumour was found on the right hemisphere near the postero-inferior surface and about 1 cm. from the mid-line. It measured 2 mm. in diameter. (*Fig.* 67.)

FIG. 67.—*Case* 1. Paramedian sagittal section of cerebellum, pons, and mid-brain, showing one tumour on the upper surface and one near the lower surface of the cerebellum. A small cyst is seen in relation to the lower tumour.

Microscopically, the larger tumour was definitely outlined by a thin zone of connective tissue, outside which the cerebellar cortex appeared to be rather compressed, but not otherwise abnormal. This connective-tissue capsule was not present around the smaller tumours. The tumours themselves consisted of a network of capillary vessels, lined by flattened endothelium between which lay larger endothelial cells with oval nuclei and scanty rather granular or foamy cytoplasm. A fine network of connective-tissue fibres reinforced the walls of the capillaries and was condensed in several concentric layers around the numerous large sinus-like spaces, which apart from this had no definite walls. In the smaller tumours some of the endothelial cells had larger bodies containing vacuoles of fairly large size, and in some areas all the cells were greatly swollen and foamy with small eccentric nuclei.

The lining membrane when examined was seen to consist of nervous tissue, in places degenerated and in other places reinforced by collagen strands. It contained numerous granules of blood-derived pigments.

This case is of special interest on account of the family history, which caused an original diagnosis of " familial cerebellar ataxia with papillœdema " to be made. It is possible, although it cannot be proved, that the brother and sister also suffered from hæmangeiomas of the cerebellum. The large cyst in the upper part of the cerebellum had been emptied before fixation and was somewhat distorted by the weight of the cerebellum which lay over it. Consequently its appearance cannot be taken as representing in any way its shape during life, when it probably formed a more or less rounded mass rising from the upper surface of the cerebellum. The tumours were otherwise typical capillary angiomas, so much so that this case was at once recalled when the tumour in *Case* 2 was seen five years later.

HÆMANGEIOMATOUS CYSTS OF CEREBELLUM

Case 2.—W. C., age 25, was admitted to the National Hospital, Queen Square, in December, 1922, under Dr. Kinnier Wilson. He had had, in 1918, a wound of the face by a bullet which entered just external to the left eyebrow and emerged below the lobe of the right ear. After this he felt quite well till August, 1922, when he found that on rising in the morning he felt dizzy and had a 'terrific pain' at the back of the head. These headaches became more frequent and more persistent, and he also had pain over the eyes. During the three weeks before admission vomiting had occurred with the headache on several occasions. Twice he had had a sensation on looking to the left as if objects in that direction were flickering up and down.

ON EXAMINATION.—No nystagmus could be made out, and beyond definite swelling of both optic discs, and unsteadiness in walking and on standing, there was no alteration in his physical condition. He died on Feb. 9, 1923, and a post-mortem examination was made of the brain only. No external tumour could be seen, but there was evident hydrocephalus. On section of the cerebellum a cyst was found which spread across the right half of the cerebellum from its outer edge to the white matter of the middle peduncle, and was about the size of a pigeon's egg (Fig. 68). On the outer border of this cyst a small round firm tumour was seen. It had a mottled surface and was adherent to the cerebellar cortex.

FIG. 68.—Case 2. Horizontal section of cerebellum looked at from below. Tumour and cyst are seen in the right hemisphere. The dentate nucleus lies close to the cyst wall.

Histologically this tumour resembled very closely those in *Case* 1; like them it contained large sinus-like spaces lined by an endothelial layer and supported by an irregularly concentric condensation of fibrous tissue. A connective-tissue capsule surrounded part of the tumour, but elsewhere this was absent. The tumour had, however, everywhere a very definite margin, as the capillary loops of which its edge was composed ceased along a curved line. Near the inner margin of the tumour was a small cyst containing clear, colloid material. The outer wall of this cyst was formed by a thick zone of connective-tissue fibres, but its inner wall—that is, the wall towards the centre of the tumour—was simply formed of tumour tissue. With Scharlach R. staining almost every one of the larger endothelial cells in the tumour was seen to contain a mass of fatty granules, a few of which had small anisotropic specks among them.

This case was in every way typical. The interval of four years between the wound and the onset of symptoms makes the connection between the trauma and the beginning of the cyst formation rather indefinite. But in view of the close relationship which existed in our *Case* 5 between the injury to the head and the onset of symptoms, the possibility of a similar relationship in this case must be borne in mind.

Case 3.—Rose W., age 33, was admitted to the National Hospital, Queen Square, under Dr. Grainger Stewart on Sept. 20, 1926. She had suffered for four months from occipital headaches and vomiting, which had been coming on in the morning with increasing severity. She had at times seen double, but not constantly. Her walking had become unsteady and she felt giddy almost all day. Recently her sight had failed considerably, and she had not been able to write properly for six weeks.

On Examination.—It was found that she was rather slow-witted and lethargic. Her memory, however, was good and her speech normal. There was severe papillœdema on both sides with hæmorrhages into the surrounding retina. Her visual acuity was 6/6, but the fields of vision were somewhat restricted. When she looked to the extreme left she had diplopia and a few nystagmoid jerkings were seen, scarcely meriting the name of nystagmus.

FIG. 69.—Case 3. Section of the tumour showing large blood spaces, and a few large darkly staining nuclei.

There appeared to be slight weakness of the right side of the face, and her head was turned slightly to the right with the chin tilted in the same direction. Sensibility to all forms of stimuli was perfect, and the voluntary power of all limbs was good. There was, however, some loss of tone in the left arm and inco-ordination of both arms, especially the left. Some inco-ordination of movement was also present in the legs. The reflexes were normal. A decompression operation over the posterior cranial fossa was performed a week after admission. The patient died on the same day.

Autopsy.—At the post-mortem a smooth-walled cyst containing clear yellowish fluid was found in the right cerebellar hemisphere near the postero-internal surface. It could be seen from the surface through the thin and translucent cortex. Microscopically it was found to have no lining membrane, the wall being formed by a very slight neuroglial condensation. Elsewhere the cerebellar tissue looked normal.

There was a dimple-like depression in the postero-inferior wall, and on section through this a very small rounded knot of tumour tissue about the size of a lentil was found. This proved to be a capillary angeioma, almost exactly similar in histological structure to those already described. There was, however, no definite connective-tissue capsule round it. It contained some large sinus-like spaces with no definite wall except an endothelial layer based on the thin walls of the surrounding capillaries. Many of the endothelial cells lying between the capillaries had large, darkly staining, elongated nuclei, and others contained a clump of several rounded nuclei. Both these appearances were interpreted as degenerative types of cell. (Fig. 69.)

Case 4.—Zillah J., age 30, was admitted to the National Hospital, Queen Square, under Dr. Adie, on Aug. 21, 1926. For about a year she had had severe pain in the top of the head whenever she bent down, but, except for this, had had no headache until the last two months. About Easter, 1926, a grinding noise in the left ear had come on and persisted for four months. For the last two months the pain in her head had been more severe and had come on frequently in the morning

on·waking. She also began to have attacks of giddiness when walking in the street and occasionally felt faint. For the last five weeks she began to have pain also· in the back of the neck. Her eyesight had become misty, and she often saw double. She had had occasional attacks in which she felt faint, but had never actually lost consciousness.

ON EXAMINATION.—She appeared to be well and cheerful. She carried her head turned slightly to the right and tilted slightly backwards. She complained of pain and stiffness in the neck, but there was no limitation of movement of the head. Severe papilloedema was present in both eyes. Very slight, fine, and rapid nystagmus was present on deviation of the eyes to the right, and a few arrhythmic jerks occurred on deviation to the left. There was hypotonia and inco-ordination of both arms and legs, most pronounced on the left side. The reflexes were normal.

A craniotomy over the left cerebellar hemisphere was performed on Sept. 3, by Mr. Donald Armour, and a large cyst in the left lateral lobe of the cerebellum was found and emptied. After this operation she was very much better and remained fairly well during 1927. But in March, 1928, her walking again became unsteady and her speech hesitant and snuffling. Headaches also became more frequent.

She was re-admitted to the National Hospital on June 13, 1928.

ON EXAMINATION.—Her optic discs were found to be pale and slightly cupped. Her vision was fair, 6/12 right and left. Her external ocular movements were full, but there was nystagmus on turning the eyes to either side. Both arms, but especially the left, were atonic and ataxic. There was loss of tone also in the legs, and ataxia of the left leg. Sensibility, motor power and reflex functions were unimpaired. Her gait was very ataxic and reeling. There was a tense hernia at the site of the previous craniotomy.

A second operation was performed on June 20, at which a cyst was tapped in each cerebellar hemisphere. The patient died three days later.

AUTOPSY.—At the post-mortem a fairly large cyst was present in the left cerebellar hemisphere and a smaller cyst in the right. That in the right hemisphere passed forwards to the outer aspect of the dentate nucleus, while that in the left reached to about 4 mm. from the roof of the 4th ventricle internal to the dentate nucleus. It was bounded internally by the mid-line of the cerebellum. On careful examination of the cyst walls, which were otherwise smooth and colourless, a small dimple was found in the postero-external wall of each cyst, and at the bottom of this a small rounded reddish tumour was found. That in the right hemisphere measured 7 by 4 mm.; that in the left hemisphere 4 by 2 mm.

FIG. 70.—Case 4. Section of edge of tumour. Capillary loops are seen passing into normal neuroglial tissue.

Histologically these tumours were capillary angeiomas and resembled very closely those already described. They were entirely without any connective-tissue capsule ; their edges, however, were fairly sharply defined. the capillary loops of which the tumour was formed ceasing along a regular line (Fig. 70). The larger tumour was unusual in that it surrounded and apparently enclosed an area of nervous tissue. which showed signs of degeneration but was easily recognizable as cerebellar cortex.

It was not possible to tell whether this piece of cortex was completely surrounded by tumour, as it was impossible to make serial sections through the whole thickness of the tumour. Throughout the larger tumour the connective-tissue septa were rather thicker than in the others, but otherwise the histological differences were very slight. Foamy cells were abundant (*Fig.* 71), and many large multinucleated giant cells were also seen between the capillaries. The walls of the cysts consisted of condensed neuroglial fibres, among which were many swollen neuroglia cells.
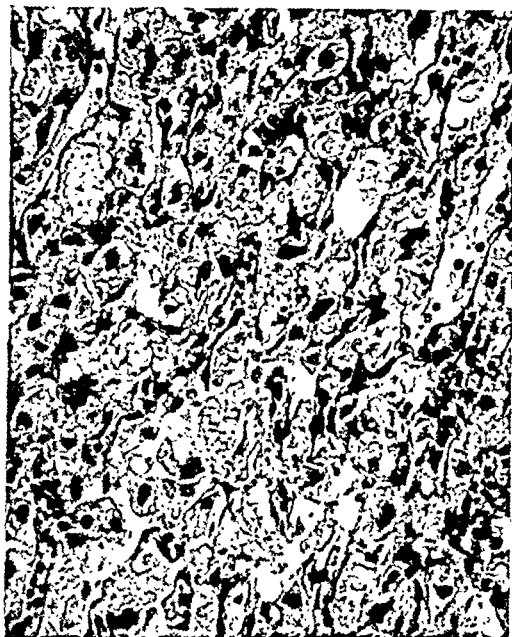
FIG. 71.—*Case* 4. Section of the tumour showing numerous large foamy cells.

Case 5.—John A., age 57, was admitted to the National Hospital, Queen Square, under the care of Dr. Kinnier Wilson, on June 22, 1928. About a year before he had slipped and fallen on the back of his head. He was dazed but not unconscious at the time, and felt no severe after-effects. But three months before admission he began to suffer from occipital headaches. About 10 days before admission he began to have attacks of vomiting, and later had had a buzzing noise in his ears. During the last week he had become weak on his legs and was no longer able to stand alone. His vision had become blurred, but he had never seen double.

ON EXAMINATION.—The patient was drowsy and slow-witted. There was no swelling of the optic discs nor true nystagmus. There was some reduction of sensibility to pinprick on the area of the face supplied by the 2nd and 3rd divisions of the right trigeminal nerve, and some weakness of the lower half of the right side of the face. Voluntary movements of the arms and legs were performed slowly and deliberately, but there was no weakness or ataxia. There was no alteration of sensibility or of the deep or superficial reflexes.

A cerebral decompression was performed by Mr. Donald Armour on July 10, but the patient only survived for a few hours.

AUTOPSY.—The post-mortem revealed a large pressure cone of cerebellum which reached far down through the foramen magnum on the left side. A cyst was found on the under surface of the left cerebellar hemisphere which ruptured as the brain was being removed from the skull. The lateral and third ventricles were considerably dilated. On section (*Fig.* 72) after hardening, this cyst measured 4 × 3 cm. in its horizontal diameter and was about 2 cm. deep. It lay external to the dentate nucleus, which was compressed inwards and forwards, and it had thinned out the cortex of the outer and lower part of the hemisphere. At its outer and inferior pole was a reddish oval tumour which measured 10 × 7 × 5 mm. On cross-section the centre was more yellow than the surface. The upper surface of the tumour lay free in the cyst, the lower surface embedded in the cortex.

Histologically (*Fig.* 73) the tumour was a capillary angeioma, very similar to the others described. The large sinus-like spaces were walled by a condensation of the connective tissue which formed the frame-work of the tumour, but minute capillaries could be seen throughout this wall and were even found in its innermost layers. Almost all the endothelial cells lying between the capillaries were honeycombed with spaces which with Scharlach R. staining were seen to contain globules of fat.

Fig. 72.—*Case* 5.   Horizontal section of cerebellum and pons viewed from above.
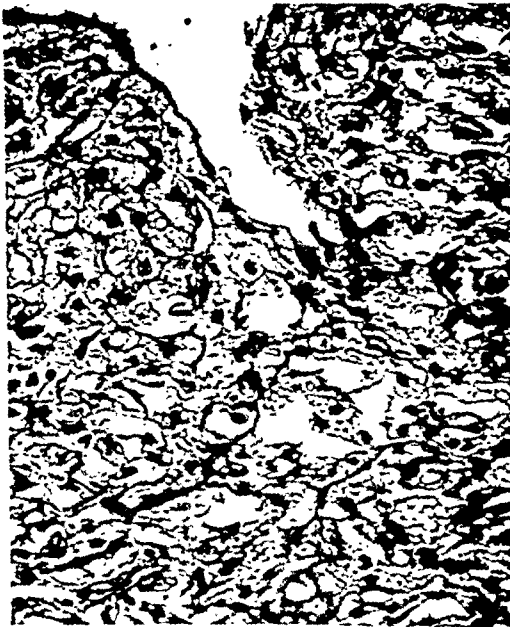
Fig. 73.—*Case* 5.   Section showing numerous foamy cells and a large sinus-like space.

Indeed, the amount of fat in the tumour was astonishing. It was present as droplets of varying size, almost all of which appeared to consist of neutral fat, as very little of the red-staining substance was anisotropic. But here and there in the centre of a mass of red globules, minute dots or rods of doubly refractile substance could be seen. The tumour had a very thin but definite capsule of fine connective-tissue strands. The wall of the cyst consisted of condensed neuroglia fibres, and no lining membrane was present.

Case 6.—J. P., male, age 56. Under the care of Sir Farquhar Buzzard.

This patient was a hard-working, highly intellectual man of good physique, and healthy in every way. In the spring of 1925 he felt very tired and went to Italy for a holiday. Whilst there he was trying to lift a little girl when he lost his balance and fell ; he was not hurt, but shaken. At times after that he found himself unsteady on his legs, but not giddy. Occasionally suffered from sharp shooting pains in the back of the head. About December, 1925, he began to have attacks of morning sickness, with occasional transient partial amaurosis. He had also noticed a tendency to deviate to the right in walking.

ON EXAMINATION.—There was some lateral nystagmus, rather more to the right than to the left. Although right-handed, the right grasp was weaker than the left. The left abdominal reflex was less marked than the right ; the left plantar reflex indefinite and the right flexor ; the left knee-jerk brisker than the right. The optic discs showed a moderate degree of papillœdema.

On Jan. 23, 1926, a bilateral cerebellar decompression was performed by one of us. A cyst was found in the right hemisphere containing about an ounce of yellow fluid, which clotted readily. It was thought to be a degenerated gliomatous cyst, as no solid tumour was detected. The pressure having been fully relieved, the wound was closed. The patient made a complete and uninterrupted recovery, and returned to his very responsible official work, perfectly fit, in April.

When he left the Nursing Home the optic discs presented a normal appearance, and the nystagmus had disappeared.

He remained quite well until July, 1928, when morning sickness re-commenced, and he felt weak in the limbs. There was no severe headache. When reading he noticed a little blurring of vision.

ON EXAMINATION.—There was some lateral nystagmus to the right ; no papillœdema, but some engorgement of the veins. The flap bulged a little and was somewhat tense. Aspiration failed to withdraw more than a few drops of fluid. In July a second operation was performed. The flap was turned down, and a small solid tumour, apparently quite definitely circumscribed, was easily removed from within the right cerebellar hemisphere. No trace of a cyst could be detected. The patient recovered even more quickly than after the previous operation, and is now quite well and back at work.

FIG. 74.—Case 6. Naked-eye appearances of the tumour, external surface and cross section. (Actual size.)

The tumour was a solid reddish mass, oval and somewhat lobulated, but more or less rounded in outline (Fig. 74). On its inner surface it appeared to be covered by a thin capsule, while on its outer surface there was a thin layer of cerebellar cortex, which could be separated from the tumour without much difficulty. The tumour measured 3·5 × 2 × 1·8 cm. and weighed 5 grm. On section the cut surface was of a deeper pink colour than the capsule. It looked fleshy and vascular, with several large spaces or channels opening on it, but no blood escaped from these on pressure, nor was coagulated blood visible in them.

Histologically it was very similar to the other angeiomas, especially to that in Case 3, in that it contained many very large endothelial cells with irregular nuclei

which seemed to be undergoing degeneration. When stained with Scharlach R. localized accumulation of fatty globules was seen filling one, two, or more neighbouring cells. The rest of the tissue was almost free from fat, but in many of the cells two or three minute fatty granules could be seen with the higher powers of the microscope. The lipoid in the larger collections was much more diffusely anisotropic than in the other tumours examined in this way.

Case 7.—Henry R., age 41, was admitted under Dr. Riddoch to the National Hospital, Queen Square, on March 27, 1925. Eighteen months before admission he had ricked his neck when tying his tie, and thereafter he could not lie on his left side in bed without pain in the neck. Six months later he found that stooping forwards caused severe pain in the back of the head and neck, and lying on the right side in bed also brought on this pain. It became more severe during the following six months, and in November, 1924, he complained of a swimming feeling in his head. He commenced to stagger and sometimes fell, usually to the left side or forwards. He also had at this time transient diplopia in the mornings. In January, 1925, he began to vomit, and the headache became so severe that he sometimes screamed with pain. Towards the end of this month he began to be drowsy. In February he had periods of aphonia or hoarseness in which his voice would leave him for an hour or two. The headache and staggering became much worse, and one day he was semi-comatose.

The patient's family history was uneventful. His parents were both alive. He himself was the eldest of ten children, two of whom died in childhood. One brother was killed in the war ; another had had fits since the age of 13, and a sister was subject to headaches. His own health had been good except for influenza in 1918 and a blow on the chest from the shaft of a cart in 1924. He had never been able to raise his left eyebrow since birth.

On Examination.—There was slight swelling of both optic discs, but good vision and no limitation of the fields. Diplopia was present on looking to the left owing to weakness of the left external rectus muscle. There was no nystagmus. Slight weakness of the lower part of the left side of the face was present. There was no inco-ordination of the arms or legs, but his gait was very unsteady and he could not stand steadily with his feet together and his eyes shut. There was no alteration in the deep or superficial reflexes. Apart from a rounded kyphosis in the upper dorsal region, his spine appeared to be normal, but movements of the neck caused pain.

An operation (left-sided subtentorial craniectomy) was performed by one of us on April 17, 1925. On exposure of the cerebellum the left lobe protruded somewhat more than the right, and was more resilient. It was split transversely, and a cyst was found lying near the middle line but not involving the dentate nucleus. It appeared to extend into the right cerebellar hemisphere, and towards the surface of the cerebellum on its left side. It was tapped, and about 2 oz. of yellowish fluid was removed. No evidence of a tumour was seen at this operation. The patient made an uneventful recovery and left the hospital on May 8, 1925. He improved steadily for over a year, and then began to have headaches, dysarthria, and unsteadiness in walking.

The cyst was again tapped in November and December, 1926. In January, 1927, he had more severe headaches and felt sick in the morning. His gait became unsteady and he had occasional diplopia and dysarthria.

The cyst was tapped for the fourth time in April, 1927, and some clear yellow fluid removed which contained about 4 per cent of protein and 2 cells per c.mm.

In November, 1927, some more fluid identical with that obtained at the previous operation was removed. Two further tappings were done during 1928. After each tapping the symptoms were immediately relieved ; but after varying intervals of time they gradually recurred, and further operative measures were decided upon.

In January, 1929, the patient was suffering from severe headaches and vomiting, and the hernia cerebelli was very prominent and tense. There was marked dysarthria, with hypotonia of the left limbs. He walked fairly well, but tended to

fall to the left. There was a moderate degree of papillœdema. Very slight nystagmus could be detected on extreme lateral deviation of the eyes.

The second operation was performed on Jan. 11, 1929, when a solid tumour was easily removed from the interior of the thinned out, semi-translucent left cerebellar hemisphere (Fig. 75). No cyst wall was seen. The most superficial part of the tumour was close to the back of the petrous bone, but not so far forward as the internal auditory meatus. Recovery was rapid and uneventful, and the patient left the hospital at the end of three weeks, greatly improved in every way, and with no cerebellar bulge.

The tumour was more or less oval, but very lobulated and irregular on the surface. It was reddish yellow in colour. Its outer surface was smooth and glistening, and where it was attached to shreds of cerebellar tissue it was quite definite tumour capsule. There was, however, no limited from these. It weighed 6·5 grm. and measured 2·5 × 2 × 2 cm. On cross-section it resembled a sponge, as it contained smooth-walled cavities of all sizes, ranging from those scarcely visible to the naked eye to those with a diameter of several millimetres. Some of the latter were obviously dilated blood-channels, but others were empty. The cut surface appeared compact parts than the outer surface of the

FIG. 75.—*Case 7.   Tumour removed.
(Slightly less than natural size.)*

rather more yellow in the more tumour.

Histologically it was a typical plexiform angeioma with very numerous, interlacing blood-channels of all sizes, from capillaries to fair-sized arteries and veins and sinus-like spaces. The capillaries and sinuses were supported by a very thin connective-tissue layer. Between these blood-channels there were numerous foamy cells, apparently of endothelial nature. With Scharlach R. the majority of these cells were found to be filled with lipoid globules, some apparently being fat and others doubly refractile cholesterin compounds including many myelin crosses. These foamy cells in some parts of the tumour were very numerous, and here and there formed aggregated masses. In other parts little could be seen except blood-channels; but the general structure of the tumour did not vary greatly from one part to another. Near one edge an included area of cerebellar tissue was present. This tumour contained considerably more lipoid than most of the others, and the amount of myelin and other doubly refractile lipoid was especially large.

The following case is added as the tumour was of the same nature, but it appeared to grow from the dorsal surface of the medulla, and it was not associated with a cerebellar cyst.

Case 8.—Elsie R., age 20, was admitted to the National Hospital, Queen Square, under Dr. Riddoch, on Jan. 4, 1929. She had suffered from morning headaches for four years. At first she had frequently vomited with the headache, but recently had not been so much troubled with this. In July, 1926, the headaches became again so severe that she had to give up work. About the beginning of 1928 she began to feel giddy in the mornings, and in September she began to have occasional 'fainting spells'.

During the past year she had had attacks of a tingling sensation in the left arm extending up to the left side of the face. Occasionally she had felt this sensation in both sides of the face. It tended to come on when she was tired. She had also become unsteady and weak in her legs. Since July she had usually felt ill in the morning, but improved later in the day. In December, 1928, her vision became blurred. This was at first transient, but recently had become constant. Her father and mother and her only brother were alive and well.

ON EXAMINATION.—The patient was an intelligent girl but rather slow-witted. She lay in bed with her head turned to the right and raised on a pillow, and said that any other position of the head brought on a feeling of dizziness. Her vision was very poor ; with the right eye she could only distinguish light from darkness ; with the left eye her vision was 3/50. Papillœdema was present in both eyes, with 5 dioptres of swelling and some retinal hæmorrhages in the right eye. The right pupil was rather larger than the left, and the right external rectus muscle was paralysed, causing strabismus on looking to the right. There was no nystagmus. There was some general weakness, hypotonia, and inco-ordination in both arms and legs. All the deep reflexes, with the exception of the biceps-jerks, were absent. The superficial reflexes were present, the plantars being of the normal flexor character. In walking and standing she held her head bent forward and to the right, and the right shoulder a little lower than the left. Her gait was unsteady and ataxic, and she tended to fall to the right. She died shortly after a cerebellar craniotomy by one of us.

AUTOPSY.—A post-mortem, limited to the head, was made sixteen hours after death. There was a pressure cone of moderate size in the foramen magnum, and between the lips of the tonsils which formed this cone a reddish vascular tumour, resembling choroid plexus, could be seen protruding in the region of the foramen of Magendie. The whole medulla was swollen and very soft, and the olivary eminences were unduly prominent. Large veins ran from the medulla towards the base of the skull ; one of these which ran over the posterior surface of the cerebellum had been ligatured. The arteries were of normal size and were otherwise healthy.

On section across the medulla in the horizontal plane it was found that all the lower half of the fourth ventricle, below the inferior limit of the pons, was filled by a pinkish-yellow, sponge-like mass of tumour which was attached

FIG. 76.—*Case* 8. Sections across medulla and cerebellum viewed from below and showing tumour *in situ.*

to the floor of the ventricle throughout its extent, but was not attached to the cerebellum where it formed the roof of the ventricle. The choroid plexus was pushed back and flattened between the tumour and the roof of the ventricle. The left foramen of Luschka was widely patent, but the right foramen was closed by adhesions round the tumour. The tumour passed out of the foramen of Magendie for a short distance. Except in so far as its shape was determined by the pressure of the ventricular walls the tumour was rounded and well defined. All over the cut surface there were large sinus-like spaces, and three large veins were seen, one at either lateral margin and one at its posterior extremity. Close to the latter was a hæmorrhagic area, probably resulting from operative trauma.

The tumour measured 2·5 cm. transversely and 3 cm. in antero-posterior diameter. It extended for about 2·5 cm. in a vertical direction. (*Fig.* 76.) The swelling of the medulla was found to be due to œdema. A small cyst had formed in the region of the right cerebellar peduncle close to the tumour, but not touching it. Apart from a considerable degree of hydrocephalus the brain was normal.

Histologically the tumour resembled the others of this series in being composed of a tangled mass of capillary vessels with numerous large endothelial cells, some of which appeared to lie within the lumen of the capillaries and some between them. The capillaries were fairly well supported with fine connective-tissue septa. Many of the endothelial cells were swollen and foamy in appearance, and with Scharlach R. staining were seen to be full of fat granules, but the number of such cells was not so great as in some of the other tumours, nor was any of the lipoid doubly refractile. Numerous larger blood-vessels of all sizes, with fairly well-formed coats of connective tissue were present. In a few of the largest of these there was also a thin muscular coat. Very thin-walled blood sinuses of fairly small size were also seen. There was evidence of neuroglial hyperplasia and some overgrowth of fibrous tissue in the layers of the medulla touching the tumour. Elsewhere the medulla was very œdematous, but otherwise healthy.

DISCUSSION.

These cases, although few in number, are very representative of those in the literature. Although more than one cyst and one tumour is rare, we have had one case of bilateral angeiomatous cysts, and one of multiple tumours, two of which were related to cysts. The bilateral cysts were at first mistaken for simple cysts, until at a later examination a minute tumour was found in relation to each of them. Our series also includes as small and as large tumours of this kind as are usually found.

CHARACTERS OF THE TUMOURS.

The appearance of the tumours is typical and characteristic. They are rounded, and sharply demarcated from the cerebellar tissue. In colour they are pinkish or often somewhat yellow, apparently from the accumulation in many of the cells of a yellowish fatty substance, or possibly from the presence in the cells of altered blood. Small cavities, some of them obviously blood-vessels, are often visible to the naked eye on cut section, but in others the tumour has a more uniform appearance. In colour and consistence they are always quite definitely demarcated from the white matter, although it is not always so easy to make out the line of junction with the cerebellar cortex. In position they affect most frequently the posterior wall of the cysts, and lie either touching, or embedded in, the cerebellar cortex. Many writers, from Hughlings Jackson onwards, refer to their contiguity to the pia mater. In our experience, and in that of Lindau, they always touch the grey matter.

In size they vary from 2 mm. to 2 cm., rarely more. Our specimen (*Case* 6) removed at operation is as large as any that has been seen. Most writers refer to them as of the size of a pea, a bean, a cherry-stone, or an almond. This size bears no relation to the size of the cyst, and large tumours may be related to small cysts (*Case* 1) or large cysts to minute tumours (*Case* 4).

In microscopic characters they agree exactly with Ewing's[6] description of plexiform angiomas. In some the vascular nature of the tumour is obvious, as it is formed of a mass of capillary vessels lined with endothelium, running

in a groundwork of collagenous fibrous tissue. In such tumours there are, in addition, larger vessels, the majority of which are sinus-like with thin walls. But even in these tumours, which represent the simplest form of angeioma, the endothelial cells lining the capillaries tend to swell and, breaking away from the connective-tissue substratum, lie free in the lumen of the capillary. Some of the capillaries are filled, and apparently blocked, by cells of this kind, and contain no blood. In addition there is a tendency for the endothelial cells to proliferate in the stroma of the tumour, and here they may form fairly large multinucleated cells, or may accumulate lipoid in their cytoplasm, becoming vacuolated in appearance. Lindau emphasizes this peculiarity as distinguishing the cerebellar angeiomas from those found elsewhere in the body. When stained with Sudan or Scharlach a large number of the cells are found to be filled with fatty granules, some of which are doubly refractile.

Other tumours are much more cellular, and the connective-tissue groundwork is very scanty. These tumours resemble cellular endotheliomas, in which capillary vessels are formed between the tumour cells. Between these extreme types all possible variants are found, and often one part of a tumour will resemble one extreme and another the opposite extreme. But between even the extremes there exists a striking family likeness, and it is impossible for a histologist who has seen one of these tumours to fail to recognize another. It is therefore remarkable that so much diversity of nomenclature exists in the literature.

The character of the cyst wall is important. In the majority of cases it consists simply of sclerosed neuroglial tissue, with overgrowth of fibres and few nuclei. Swollen neuroglia cells are sometimes seen, but there is never any resemblance to gliomatous tissue. Usually there is no lining membrane or epithelial covering, but occasionally a few cells resembling endothelium are seen on the wall. In some cases a definite lining membrane has been described, and one of the cysts in our *Case* 1 was lined by such a membrane in which granules of hæmatoidin and hæmosiderin were found, giving evidence of previous hæmorrhage into the cyst. Usually, however, the wall does not differ in colour from the white matter of the cerebellum. The character of the lining membrane when it is present and the normal character of the neuroglial tissue surrounding the cyst make any attempt to remove the cyst wall unnecessary.

It is remarkable with what constancy the dentate nucleus is spared. It is often pushed aside and may be flattened by the pressure inside the cyst, but neither in our cases nor in those previously described is it ever either destroyed or broken into by the enlargement of the cyst. This is all the more remarkable if we consider the size of the cysts and the way in which they thin out the cerebellar cortex : but it is an encouraging fact to bear in mind, as the experience of the war showed that complete clinical recovery might follow lesions of the cerebellar hemispheres if the dentate nucleus was intact (Holmes[7]). Ernest Sachs[8] relates how one of his patients, one month after the removal of the tumour from the wall of a cerebellar cyst, went for a three-mile walk. In this case the cyst had on several occasions been emptied, either by open operation or by puncture, with only temporary relief. When seen three years after the last operation the patient was still perfectly well.

MODE OF GROWTH OF THE TUMOURS AND CYSTS.

According to Ewing and most other authorities, capillary angeiomas are of congenital origin. It seems likely, however, that they may grow at the expense of the tissues round them. The appearance of the edge of the tumour in our cases suggests a continued outgrowth into the cerebellum. In our Cases 6 and 7 it is unlikely that the tumour would have been overlooked at the first operation if it had been as large then as when it was removed. If growth does take place at the expense of the cerebellar tissue, this would explain the amount of fat seen in the larger endothelial cells of the tumours. The character of the fatty inclusions, especially the presence of anisotropic particles in the fat globules, agrees well with its possible origin from broken-down myelin.

The symptoms in most cases, however, appear to be due rather to the increase in the size of the cysts than in that of the tumours. Two possibl[e] origins have been suggested for the cysts: (1) That they are formed by the degeneration and liquefaction of the tumours; and (2) That they are caused by the seeping of plasma from the vascular tumours. We can say quite definitely that, at any rate in so far as angeiomatous cysts are concerned, they do not arise in the first manner. The rounded shape of the tumours, and the complete absence of any tumour tissue from other parts of the cyst wall, completely negative this possibility. Gliomatous cysts may arise to some extent from the degeneration of the tumours; but where the tumour is minute and the cyst large, as in Williamson's[9] first case, the theory which he put forward in 1892, that all except a small knot of tumour had degen-erated, appears to us in the light of our present knowledge quite untenable.

The second suggestion as to their origin seems much more reason-able. We cannot be certain how the formation of the cyst began, but the history of trauma given by two of our patients, as also by the patient of Cushing and Bailey, and by both the brothers whose cases Seidel[10] reported, is very suggestive. In our two oldest patients, as in Seidel's patient, symptoms of intracranial pressure came on about six months after a fall which was not severe enough to cause any very bad immediate symptoms. In Cushing and Bailey's case the evidence of hæmorrhage from the angeioma at the time of the injury was more direct, as neck rigidity and occipital headache came on at once, and lumbar puncture gave a blood-stained fluid; symptoms of intra-cranial pressure were, however, deferred for three years. In our second case symptoms referable to the cerebellar cyst came on four years after a wound by a bullet which passed through the face from side to side and must have jarred the skull. The evidence of direct etiological connection between the injury and the cyst formation is therefore in this case slender enough, although it is fairly definite in the older cases. Traumatic cysts are known to occur in the cerebellum as well as in the cerebral hemispheres, and when a small angeioma is already present probably no great degree of trauma is needed to cause slight hæmorrhage or œdema round it. Once the formation of a cyst has begun, it is likely to increase in size as the vascular tumour in its wall exudes plasma into it. The character of the cyst wall suggests that the increase in size is slow, as the neuroglial cells and fibres are usually of an adult type,

and there is no evidence of recent tearing or disintegration of the tissues round the cyst. In fact, the cyst walls are always smooth, and one is surprised to find that they are not lined by an endothelial layer.

FAMILIAL INCIDENCE.

Our first patient gave a history that a brother and a sister had ' died of the same thing '. It was impossible, owing to the war conditions which then obtained, to confirm this history, and of itself it would be of little value. On reviewing the literature we find, however, that a familial incidence of this affection is not very uncommon. Reference has already been made to Seidel's case. The patient's brother who, like himself, was a tight-rope dancer, had shown signs of cerebellar tumour soon after a fall from his rope ; he had been operated on and a cerebellar cyst found. Seidel's patient had, in addition to a cerebellar cyst, a hæmangeioma of the retina. In the case reported by Cushing and Bailey, in which a retinal angioma was present in addition to the cerebellar growth, the patient's father and paternal aunt had both died from ' cystic sarcomas of the brain '. Lindau recorded, in 1927, a further case of angioma of the retina with cystic hæmangeioma of the cerebellum, cystic kidneys and pancreas, and hypernephromata in the kidneys and epididymis. The patient's brother had died from what was presumed to be a cerebellar tumour.

No doubt careful inquiry would reveal other familial cases. It is not indeed remarkable that a disease which, like this, is based on a congenital maldevelopment dating back, as Lindau considers, to the third month of foetal life, should show a tendency to affect more than one member of a family. The fact of familial incidence is, however, of great clinical value, as a history of this kind in a case of intracerebellar tumour would be strong presumptive evidence that we were dealing with a cystic hæmangeioma. Familial cases of eighth-nerve tumour are known, but are very rare ; and gliomatous tumours practically never affect more than one member of a family.

The presumptive evidence given by a family history of cerebellar tumour is, however, much less definite and certain than the presence of a retinal hæmangeioma in the patient himself. This in a case with cerebellar symptoms is practically pathognomonic of hæmangeiomatous cyst of the cerebellum, although the tumour might lie in some closely related part of the brain-stem, such as the pons or medulla. Cushing and Bailey have found in their very numerous records no case of hæmangeiomatous cyst above the tentorium, nor in fact elsewhere than in the cerebellum. But similar tumours have been found in the brain-stem and cord by other observers, and in the latter situation have sometimes been related to cysts.

DISTINCTION OF ANGEIOMATOUS CYSTS FROM GLIOMATOUS CYSTS.

It is not always easy to tell from a naked-eye examination whether a cyst is due to an angioma or to a glioma, as some gliomatous cysts resemble very closely those we have been describing. Many, however, are easily distinguished by their irregular or multilocular shape, by the presence of trabeculæ passing

from one wall to another, and by the obvious presence of tumour tissue in more than one part of their walls. Angeiomatous cysts are so constantly rounded and smooth-walled that any departure from this appearance should suggest the presence of a glioma.

It is usually not difficult to distinguish an angeioma from a glioma when a knot of tumour tissue is found in the wall. The reddish-yellow colour of the cut surface of the angeioma, its clearly-defined rounded outline, and the presence in it of multiple minute cavities distinguish it fairly readily from a gliomatous nodule, which, apart from obvious hæmorrhages, is usually whiter and smoother, and merges more gradually into the surrounding brain tissue.

The apparent presence of a lining membrane is of equivocal value as a distinguishing mark. Such an appearance is usually merely the result of hæmorrhage into the cyst which has stained the inner layers of the walls, a condition which may be found in either form. As we have seen, removal of such a lining membrane is as unnecessary in the case of an angeiomatous cyst as it is likely to be ineffectual in the case of a gliomatous cyst.

THE QUESTION OF SIMPLE CYSTS OF THE CEREBELLUM.

Lindau records two cases of what appear to be simple cysts of the cerebellum. Both were museum specimens, and in neither was the wall of the cyst complete, so that it is possible that a small tumour existed in the part of the wall which had been removed. In one of the cases the cyst resembled an angeiomatous cyst in lying in one cerebellar hemisphere and in pushing the dentate nucleus aside without destroying it. In the other case the cyst lay in the mid-line under the vermis, which is an unusual situation for an angeiomatous cyst. The possibility of a minute tumour causing a large cyst, as in our *Case* 4, and in a case recorded by Williamson, makes us doubtful about the existence of simple developmental cysts of the cerebellum. One of the tumours in our *Case* 4 was so small and—lying in a dimple in the wall of the cyst—was so hidden from sight that it was at first overlooked. In one of Williamson's cases the tumour was very minute, measuring only 2.5×4 mm., in a cyst the size of a pigeon's egg. Certainly it is the duty of the surgeon, when he encounters a cyst in the cerebellar hemisphere, to search carefully for the tumour, or if it is not apparent, to remove the tissue round any dimple that may be seen projecting into the cerebellar cortex. Our *Cases* 6 and 7, and the case of Sachs which we have quoted, suggest that by doing so the patient may be saved from a recurrence of symptoms and a second operation.

CONCLUSIONS.

1. The majority of cerebellar cysts have capillary hæmangeiomas in their walls. These angeiomas are always embedded in the cortex of the cerebellum, and frequently lie in a small dimple in the wall of the cyst.

2. Angeiomatous cysts of the cerebellum frequently co-exist with retinal angeiomas, hypernephromas, or cystic disease of the kidneys or pancreas.

3. Cerebellar cysts of this kind may have a familial incidence, occurring in members either of the same or of successive generations.

4. A close relationship to a trauma of the head or a severe fall has been established in several cases. It is probable that the trauma may start the formation of a cyst in a patient who already has an angeioma of the cerebellum.

5. Angeiomatous cysts have no lining membrane. Their walls are formed by a condensation of the normal neuroglia.

6. Simple emptying of such a cyst rarely brings about a permanent cure. Removal of the tumour from the wall of the cyst seems, however, to prevent the recurrence of symptoms.

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SPECIAL ARTICLES
ON SURGICAL TECHNIQUE.

SURGICAL TECHNIQUE OF PULMONARY ABSCESS.

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ABSCESS in the lung arises from a localized infection which may result from :
(1) a preceding attack of either lobar pneumonia or bronchopneumonia,
(2) an infected embolus, or (3) inhalation of infected material. The last two
causes are more common precursors than pneumonia, and in the large majority
of cases the pulmonary infection has succeeded some general operation or
one upon some portion of the respiratory tract. Experimentally, it has been
possible with certain precautions to produce abscesses of both embolic and
inhalation types. Multiple foci resulting from these causes eventuate in a
condition of diffuse septic pneumonia, and when the infection is localized but
of great virulence, or the individual resistance low, the condition of gangrene
supervenes.

Those abscesses arising as a result of pneumonia or of embolus are very
similar in character, both as regards their clinical manifestations and the
radiographic appearances. When they are single, and the patient has not
been too exhausted by the previous illness, the prognosis with regard to
eventual cure is reasonably good if they are adequately treated at the right
time. Those in which inhalation of septic material has been the primary
cause, on the other hand, rarely recover as completely as the former class.
It would appear that this is due to delayed diagnosis, the condition being
confused with bronchiectasis, purulent bronchitis, and sometimes called
unresolved pneumonia. With more modern methods of diagnosis and the
more general adoption of X-ray examination in doubtful chest diseases these
diagnostic errors should become less frequent.

This is not the occasion to discuss the general signs and symptoms of
pulmonary abscess, but in order to carry out the surgical treatment efficiently
it is essential that very careful localization of the abscess should be ensured
before operation. X-ray examination of the chest in these circumstances is
essential. Skiagrams should be taken in the antero-posterior, lateral, and
oblique positions, and in certain cases stereoscopic views may afford useful
information. Abscesses following the lodgement of an embolus and pneumonia
are generally similar in their radiographic appearance. In the early stages
and before leakage into a bronchus has occurred, the abscess appears as a

somewhat diffuse homogeneous shadow in the clear lung area, generally inclined to be roughly circular or oval in outline (*Fig.* 77). Following rupture into a bronchus it is common to see a definite line of fluid level with a clearer area of air above, which fluid level changes with alteration in the position of the patient. This type might be termed 'the simple chronic abscess' (*Fig.* 78). In abscess following inhalation of infected material, the area of shadow is commonly more extensive and diffuse. Leakage into the bronchus occurs early, but it is uncommon to see any fluid level or to be able to distinguish the presence of air in the abscess by radiographic methods. This variety is termed 'the bronchiectatic abscess', and arises primarily in the bronchioles.

FIG. 77.—Simple chronic abscess of lung before rupture into bronchus.

FIG. 78.—Same case as *Fig.* 77 after rupture into bronchus. Note fluid level with air in upper part.

Further confirmation can be obtained by the introduction of lipiodol into the bronchial tree. In the simple chronic abscess the thick oily solution is unable to enter the abscess cavity owing to the congestion and œdema of the mucosa of the communicating bronchus. A similar condition is often present in one of the larger bronchi in cases of bronchiectatic abscess, and the sudden arrest of the lipiodol in one of the secondary bronchi can be clearly seen. Spreading out in a more or less triangular area, from the blocked bronchus as an apex, is the shadow of the abscess, this area being completely devoid of lipiodol—the 'silent area' (*Figs.* 79, 80). In bronchiectasis the dilatation of the tubes is clearly shown.

TREATMENT.

A certain proportion of abscesses in the lung clear up entirely without operative treatment. Under these circumstances all patients should be given the benefit of measures which will induce drainage through normal channels —the bronchi. All possible infective foci in the upper air-passages—teeth,

sinuses, tonsils—should be carefully examined, and if any source of infection is found measures for its elimination should be instituted. Natural drainage is encouraged by placing the patient in such a position as will most easily empty the abscess cavity into the main bronchial tubes—postural drainage. This position will vary with the site of the abscess, and to a certain extent in different individuals. When the optimum position is found it should be occupied for gradually increasing periods at least twice a day. The constant presence of spirochætes in the pus from almost all types of pulmonary abscess suggests the administration of one or other of the arsenical preparations. Intravenous administration of novarsenobenzol, in small doses at intervals of five to seven days, is of advantage. Should the abscess show definite signs of healing both from the clinical and—more important — from the radiographic examination, operative interference should be withheld ; but if in spite of the above measures there is no improvement, or even deterioration, surgical drainage should be instituted.

Pre-operative Treatment.— No effort should be spared in getting the patient into as fit a state as possible before operation, and in certain cases this will require such measures as transfusion of blood ; rectal administration of fluids with glucose, cardiac stimulants, and the judicious use of hypnotics for the induction of

FIG.   79. — Bronchiectatic abscess (inhalation). Unfilled area between two normally filled areas. Small blocked bronchus shown by arrow.

sleep for a day or two before operation are all of value. On the day of operation every effort is made to induce the patient to evacuate, by posture, the fluid contents of the abscess cavity.

Anæsthesia.—Local anæsthesia is the method of choice in these cases. It may be preceded by an injection of morphia, $\frac{1}{6}$ gr., atropine $\frac{1}{150}$ gr.. hyoscine $\frac{1}{150}$ gr., injected half an hour before operation. Paravertebral anæsthesia is quite unnecessary, and local infiltration with anæsthetization of the intercostal nerves involved is invariably sufficient.

When general anæsthesia is used some form of positive-pressure administration should be adopted, and gas and oxygen is the anæsthetic of choice. By inducing positive pressure, when the abscess is opened aspiration into and flooding of the bronchial tree by the purulent contents is prevented.

Operation.—Abscesses arising in the upper lobes are best approached through an upper axillary incision, of the middle right lobe through an anterior incision, and of the lower lobes through posterior incisions, the exact position depending upon the site of the abscess. That point on the chest wall nearest to the abscess is chosen in order as far as possible to avoid interference with and damage to normal lung during the operation.

OPERATION IN ONE STAGE.—A vertical incision of from three to four inches in length is made through the superficial tissues of the chest wall, exposing the ribs and intercostal structures. A rib overlying the abscess is resected subperiosteally, and the subjacent periosteum and pleura are examined. The presence of œdema and a sensation of firmness is good evidence of adhesions between the pleural layers. An aspirating needle is now inserted into the subjacent adherent lung and an attempt made to enter the abscess. The presence of the point of the needle within the abscess cavity is shown by the aspiration of pus or of foul-smelling gas.

When the abscess is somewhat deep-seated it is advisable to leave the needle *in situ* and to incise the lung alongside the needle until the abscess cavity is exposed. The

FIG. 80.—Same case as *Fig.* 79, lateral view. Note 'silent area' with small blocked bronchus near hilum, indicated by arrow.

small track may be enlarged with forceps to allow adequate exposure, but it is better practice to use a cautery at a dull red heat, as vessels with their walls held wide open by the rigid inflamed tissue will be sealed by the cautery and embolism thereby avoided. The contents of the abscess, pus or inspissated mucopus, are carefully removed. Hæmorrhage from the walls of the cavity is rarely serious and can be controlled by light packing with dry gauze for a short while, or with gauze which has been soaked in coagulen and squeezed almost dry. Care should be taken not to allow the gauze to enter the bronchus, as it will result in excessive coughing attacks.

Drainage should be carried out by means of a soft-walled drainage tube, but it is necessary, when there is a considerable area of induration around a large abscess, to remove a portion of the rib above or below (whichever is

better in the individual case) with the intercostal structures between the resected ribs, to permit retraction of the pulmonary tissue as healing occurs. In the majority of cases close suture of the chest wall around the tube is to be avoided, and, to prevent a spreading cellulitis, the wound should be left open and lightly packed with gauze.

In the bronchiectatic abscess the bronchial fistulæ show themselves by respiratory sounds at the time of operation, but in the simple chronic abscess communication between the bronchus and the abscess cavity will not be free for two or three days—i.e., until the œdema of the mucosa has disappeared.

OPERATION IN TWO STAGES.—Where, after resection of a rib, adhesions between the pleural layers are absent—in some cases the lung can be seen moving freely beneath the parietal layer—it is inadvisable to open the abscess in one stage. A portion of the adjacent rib is resected and the intercostal structures between the resected ribs are separated from the parietal pleura and removed. Careful palpation of the subjacent lung through the intact parietal pleura may disclose evidence of induration. Should this be the case, a pack of iodoform gauze is laid against the parietal pleura and the superficial parts of the wound are loosely closed over it. Firm pleural adhesions should be present in six or eight days as a result of the irritation caused by the pack.

FIG. 81.—*Stage I of two-stage operation. In this case the pleura has been opened and the indurated area brought to the surface and sutured. (Inhalation abscess.)*

When no induration can be felt in the lung a small incision is made in the parietal pleura and the finger inserted to palpate the lung. If air is allowed to enter the pleural space slowly there is no shock in this procedure. The indurated portion of the lung is brought up to the opening in the pleura, and by means of an overlapping suture is fixed to the chest wall. This suture should pass through firm tissue—including the periosteum of the resected ribs and the intercostal muscles—around the edges of the wound (*Fig.* 81), not through the parietal pleura alone, which is likely to tear. The whole wound is again lightly packed with iodoform gauze for

several days to allow firm adhesions to form, and the skin is drawn together with a few sutures.

Where previous localization of the abscess has been inexact it may not be possible to bring up the involved area to the operation wound owing to the presence of pleural adhesions overlying the abscess, in which case another incision and rib resection will be required over the adherent area, the original wound being carefully sutured without drainage.

The second-stage opening of the abscess is performed in six to eight days, without anæsthetic of any sort except perhaps the administration of a small dose of morphia. After the removal of the gauze pack the abscess is sought by an aspirating needle, and the cavity opened by a cautery (*Fig.* 82). Drainage is instituted as described above in the one-stage operation.

After-treatment.—Immediately after operation the patient is returned to bed and placed in a semi-erect position, inclined towards the affected side. Expectoration is aided during coughing by firm manual support over the operative area.

The wound will require frequent change of dressing, and fœtor due to anaerobic infection may be diminished by the passage of oxygen in a slow stream through a fine catheter, introduced either through or at the side of the drainage tube. In order to eradicate the spirochætal infection almost invariably present, arsenic may be administered either into a vein or into the muscles as soon as the immediate post-operation reaction has passed off.

Fig. 82.—*Stage II* of two-stage operation. Firm adhesions are present. The original suture can still be seen. Abscess opened, after aspiration, with cautery. The openings of the bronchi can be seen in the floor of the abscess. (Inhalation abscess.)

In a well-drained case the sputum steadily diminishes in quantity and becomes less purulent and more mucoid in type, the appearance of the wound and its discharge improving at the same time. Drainage should be maintained until the sputum is negligible in quantity, the abscess cavity obliterated except for the drainage track, and the discharge almost completely serous. In the embolic and post-pneumonic abscesses complete healing may occur in six to eight weeks, but in the abscesses following inhalation healing may be delayed for several months. This is especially the case when diagnosis is delayed, treatment has been instituted at a late stage, and secondary bronchiectasis is already established.

Prevention of Secondary Bronchiectasis.—Abscesses in the lung heal in a precisely similar manner to those elsewhere in the body by the approximation of their walls and their final coalescence. In soft parts elsewhere the destruction of tissue due to infection is balanced by the elasticity of the surrounding tissues, which allows fibrosis to obliterate the cavity by contraction. Conditions in the chest, however, are altered by the comparative rigidity of the chest wall. Larger abscesses in the lung will, following drainage, slowly contract, the surrounding structures—such as chest wall, diaphragm, and mediastinum—giving way to some degree. In a number of cases, and especially in older subjects, this retraction is insufficient to obliterate the cavity. The thin-walled bronchi now commence to be pulled upon by the contracting fibrous tissue around the abscess. Distortion and dilatation of the bronchi result, and are soon succeeded by secondary infection, when the complete picture of bronchiectasis is established.

FIG. 83.—Same case as *Fig.* 77 after drainage, before lipiodol injection.

This process may delay healing of the external wound, or may follow external healing of an incompletely drained abscess. In the former case purulent expectoration and discharge from the wound will persist in spite of adequate drainage; in the latter, expectoration—which had once disappeared — will reappear, become more purulent, and increase. In both cases an attempt should be made to diminish the capacity of the hemithorax and thereby produce relaxation of the lung. Operative measures are preceded by lipiodol injection and X-ray examination to demonstrate the bronchial dilatation (*Figs.* 83, 84).

In early cases of secondary bronchiectasis, and especially those in which the healing of the external fistula is followed by increase in sputum, phrenic avulsion is often curative, and in all cases should be given a trial before more serious measures are contemplated.

FIG. 84.—Same case as *Fig.* 83 after lipiodol, showing localized bronchiectasis resulting from contraction of abscess. Permanent healing without symptoms followed phrenic avulsion.

In those in which bronchiectasis is established before the abscess has been opened, phrenic avulsion will need to be followed by prolonged drainage.

Fig. 85.—Generalized bronchiectasis secondary to drainage and external healing of large pulmonary abscess. Condition one year later required complete thoracoplasty.

When bronchiectasis secondary to a healed abscess has become well established and generalized, complete thoracoplasty preceded by phrenic avulsion will be necessary (*Fig.* 85).

DUODENAL ULCERS FOLLOWING BURNS: WITH THE REPORT OF TWO CASES.

By JOSEPH J. LEVIN,

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CURLING in 1842 first described a duodenal ulcer following a burn, and Sherren in commenting on this in Choyce's *System of Surgery* says, " Ulcers occurring in the duodenum complicating severe burns were described by Curling in 1842 (Fig. 380), and it is said they may also be present in the stomach, and in the intestine lower down. Usually single, they are met with most often in the first portion and begin as hæmorrhagic erosions. They are said to occur, as a rule, from seven to fourteen days after the burn, but they may be discovered earlier—in one case (Parfick) they were seen within eighteen hours. These ulcers often lead to a fatal issue within a few days, from hæmorrhage or perforation. They were most frequently met with by older writers. Thus Fenwick, from the statistics of Holmes, Erichsen, Perry and Shaw, found this complication in 6·2 per cent of all fatal cases of burns. These ulcers are now not often found after burns, and *some authors deny that the two conditions are associated.* Various explanations have been given of the development of the acute ulcers, but they are probably of toxæmic origin, and can thus be brought into line with other acute peptic ulcers."

Similar views seem to be held by most text-book writers, and the position is that the majority of authors are agreed that duodenal ulcers do occur after burns ; but one gains the impression that very few present-day surgeons or pathologists have actually seen such ulcers, and there appears to be some divergence of opinion as to the exact portion of the duodenum in which they occur, whether they occur in children or in adults, and whether they are likely to perforate or not.

It would be excusable, therefore, if after many years of a type of practice in which one would expect to meet such cases and did not meet them, one began to doubt whether duodenal ulcers really did occur to-day after burns, and thought that possibly the mere assertion that they did so was one of those statements which have been taken over from one text-book to another without actual verification by the different authors. I say " really did occur to-day " because there would appear to be some justification for thinking that such ulcers did occur more frequently in, say, Curling's time than to-day, for three reasons : (1) Because oil lamps, candles, and gas lamps have to a large extent been superseded by electric light ; (2) Because of the more cleanly treatment of burns ; and (3) Because of the decrease of drunkenness in later years, especially in the British Isles since the War. (Children of the working classes are possibly better protected by their parents.) The experience of my predecessor as District Surgeon in the Central Area of Johannesburg

(Dr. Heberden), who definitely informed me that, although during the ten years he held the post he had always particularly looked for duodenal ulcers when performing post-mortem examinations in cases of burning and scalding, he could not recollect ever having seen one ; the experience of the other two District Surgeons in Johannesburg (Dr. W. Girdwood and Dr. R. Ray), one of whom has held office for over fifteen years and the other for nearly ten years, without having seen such an ulcer after a burn ; and my own experience until recently rather tended to support the doubt. I have held the post of District Surgeon for thirteen and a half years and have rarely failed in cases of burning and scalding to look for duodenal ulcers, and until recently I have never seen one. The post-mortem examinations are carried out in the Government Mortuary, where at any rate during the last thirteen and a half years we have averaged between 900 and 1000 examinations per annum. All persons dying from unnatural causes and all deaths from accidents (including all burning and scalding accidents) in the Johannesburg magisterial area (approximately 100 square miles) and for some distance beyond, must come to this mortuary. Our experience, therefore, is not inconsiderable, yet in spite of this mass of suitable material neither my predecessor nor my colleagues in this type of work nor I (until recently) had seen a case.

Now, however, my doubts have been set at rest. A couple of years ago I found a small ulcer in the duodenum of a child who had died from the effects of burns. I have lost the specimen, and my recollection of the case is not very accurate in details, but there is no doubt about three facts in connection with the case : (1) The victim was a child ; (2) Death was due to burns ; (3) There was a duodenal ulcer. In addition to this case I may say that on one or two occasions I have seen a duodenitis after burns or scalds.

On Aug. 1, 1928, I examined the dead body of a native female child, age 3 years and 11 months, who had died on July 31, as a result of scalds. The child had been accidently scalded on July 21 and was admitted to the Non-European Branch of the General Hospital, Johannesburg, on that day. The hospital notes say that she was suffering markedly from shock on admission. She recovered from the shock, however, in about thirty-six hours, and then the stage of reaction followed by that of toxæmia set in as evidenced by the temperature chart. The temperature varied between 99° and 102° for the following eight days, the pulse from 116 to 140, and respiration from 22 to 44. The child died on the tenth day after admission.

At the post-mortem examination I found that there had been extensive scalds on the front of the neck, left side of the neck, and behind the left ear. There was also extensive scalding of the left arm, the front and left side of the chest and abdomen, left scapular region, left lower limb, left buttock, and right arm. The scalds were septic. The right lung was adherent to the diaphragm by recent adhesions. There were small patches of lymph on the surface of the right lung, and there was evidence of bronchopneumonia in the lung.

On the anterior surface of the first part of the duodenum I found a perforated ulcer (*Fig.* 86) which I demonstrated to half a dozen members of my class of Forensic Medicine who were in the mortuary. Then, before disturbing the parts, I sent for Dr. J. Harvey Pirie, late Senior Pathologist to, and

at present engaged in research work at, the South African Institute for Medical Research, to verify my 'find'. I removed the duodenum and stomach and had the specimen preserved and photographed at the South African Institute for Medical Research, where it has also been seen by three
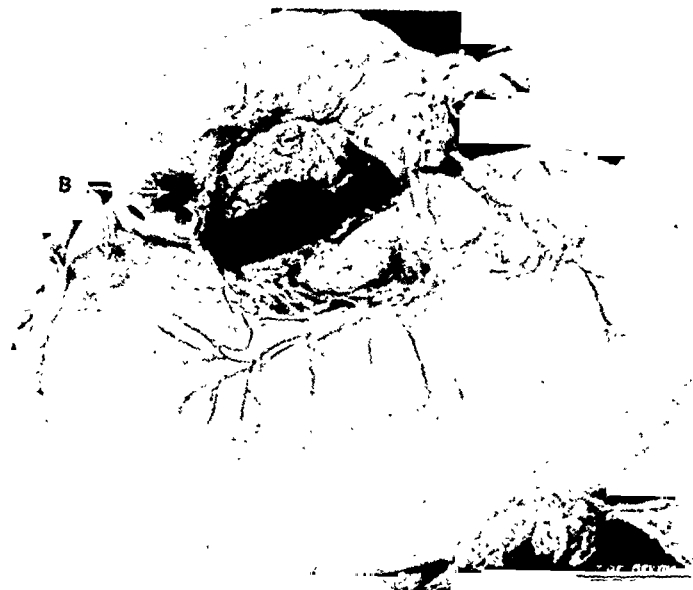
FIG. 86.—Showing perforated ulcer on the anterior surface of the first part of the duodenum.   B, Bile staining.

other experienced pathologists. There was no evidence of peritonitis or escape of stomach or intestinal contents. One therefore concluded that the ulcer had perforated shortly before death and the bronchopneumonia following the burns was the cause of death.

PATHOLOGY.

Pathologists are apparently not yet agreed about the exact pathology of duodenal ulcers associated with burns. Some think that they are due to vascular thrombosis, others that they are due to the elimination of toxins from the liver by way of the bile-duct, the toxins being absorbed from the septic burnt or scalded areas. It seems to me, however, that if one accepts as a theory for shock the following sequence of events—trauma resulting in lowered blood-pressure followed by interference with tissue metabolism ending ultimately in an acidosis—a more or less satisfactory pathology for duodenal ulcer associated with burns can be evolved which fits in with the usually accepted theory for the causation of duodenal ulcers generally.

In severe burns four stages develop as a rule: (1) The stage of profound shock (more profound in children); (2) The stage of reaction; (3) The stage of toxæmia; (4) The stage of recovery or death.

As a result of the shock if there is not a *true* hyperacidity one can safely

assume that the alkaline reserve has been seriously depleted and that there exists at any rate a *relative* hyperacidity. Toxins are absorbed into the tissues in cases of burns, first as a result of the production of a peculiar substance, said to be akin to histamine, and secondly as a result of the sepsis in the burnt areas. We have therefore the toxins which devitalize the duodenal mucous membrane causing possibly an erosion, and also the hyperacidity which favours the full development of an ulcer.

The localization is explained, as all duodenal ulcers are explained to-day, by the tortuosity of the vessels of the lesser curvature of the stomach and first part of the duodenum and their relatively poor anastomosis rendering them more liable to thrombosis.

The whole present-day theory of the development of gastric and duodenal ulcers is, to my mind, unsatisfactory, but I suggest that by bearing in mind the ultimate acidosis of shock a theory for the development of duodenal ulcers associated with burns, *especially in children*, can be conveniently fitted in.

CONCLUSIONS.

1. Acute duodenal ulcers are found post mortem in cases of death following burns and scalds, but rarely so.

2. There would seem to be special reasons for their occurring in the first part of the duodenum.

3. These ulcers may perforate.

4. The ulcers do occur in children (Curling's case and the two cases here recorded), and are possibly more likely to do so because of the more profound shock in the young.

THE TREATMENT OF CONGENITAL DEFECTS OF THE BLADDER AND URETHRA BY IMPLANTATION OF THE URETERS INTO THE BOWEL: WITH A RECORD OF 17 PERSONAL CASES.

(Based on a Hunterian Lecture delivered at the Royal College of Surgeons of England, on Feb. 8, 1928.)

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INTRODUCTION.

An early interest in the incontinent bladder has perhaps been the means of attracting these cases to my care, and I hope that a review of the results will stimulate further interest in the treatment of these distressing deformities, and will justify the method which has been employed.

As a dresser in the wards of the old Royal Infirmary at Newcastle-upon-Tyne in the year 1896 and afterwards, I saw much of two cases of ectopia that were being treated painstakingly and laboriously by the plastic measures then in vogue, and I remember vividly the utter futility of the conscientious efforts of that most careful and painstaking surgeon, the late Dr. G. H. Hume. The distress of another patient (*Fig.* 87), whose ardent nature impelled him to seek that sexual gratification which his disability denied him, also made a profound impression on my mind, and I have never lost sight of the importance of the sexual problem in these cases. At that time most surgeons were discontented with these plastic operations, for, at the best, they could only make it possible for the patient to drag out a less miserable existence with the aid of some form of apparatus to catch the urine.

In these cases I think the fortitude of the patients was even more to be admired than the perseverance of the surgeons. One patient, a young man of 20, who subsequently came under my own observation, submitted to nine plastic operations in two years, the final result being depicted in the photograph (*Fig.* 88 *b*), which shows that the maximum result obtained was the protection of the upper part of the exposed bladder by a flap of skin, and that he still has to wear a large and cumbersome apparatus. At night the latter is useless and he lies in a pool of urine. As may well be understood, this patient is a determined Northumbrian, for, at 15 years of age, before any operation was contemplated, he started to work in the pits, and it was only the non-success of the urinal which he then wore that induced him to seek surgical aid. Ever since the last operation he has continued at work, and now at 41 years of age he is regularly employed. He is in good health, and without any evidence of infection or of renal insufficiency. But this case is nothing compared with that of a boy recorded

by Stewart McKay,[1] who between the ages of 4 and 10 endured no fewer than forty-nine such operations until he was finally relieved by the transplantation of the ureters into the bowel.

In those early days I also saw attempts made to establish a permanent opening between the bladder and the rectum, the idea being that the route into the rectum having become stabilized, the sphincter ani would control the escape of urine and the bladder could be completely closed at a later date. Alas! all these methods were unavailing, and both surgeons and patients became inured to disappointment. Further, I was brought up in the belief that the union of the ureters to the bowel was always followed by ascending infection of the kidneys which soon proved fatal, and that position was generally accepted amongst surgeons, and I fear has not quite disappeared even to-day.

In 1911 new interest was aroused in this subject as the result of a paper by Sir Harold Stiles,[2] which he read before the American Surgical Association in Denver City, on "Epispadias in the Female and its Surgical Treatment, with a report of Two Cases". He there described a method which he had devised of implanting the ureters into the sigmoid which aimed at making a valvular opening, by which he hoped to lessen the

FIG. 87.—The parts from an adult, the subject of complete ectopia vesicæ. Note the dilatation of the ureters and the well-developed testicles; also the wide separation of the pubes, and the very thick and strong interpubic ligament.

risk of ascending infection. The cases were both female children, on whom he had operated by this method with good results. Personally I was prepared for the announcement, for in March of the previous year in Edinburgh I had seen the first patient on whom he had carried out his operation. She was then in good health and with perfect rectal function and control. (See p. 176 for further history of these patients—Cases C. D. and A. McK.)

I was at once arrested by his work, for I conceived that at last there was some hope of relieving the miserable condition of this class of case. Soon after the publication of his paper Sir Harold told me of a visit which these children had made to the theatre, and I was fascinated by the story of these little girls who were able to sit in comfort and enjoyment throughout the whole performance of *Peter Pan*.

Such is the story of my personal introduction to the treatment of these cases by transplantation of the ureters. But the whole history extends over many years—since the attempt of Mr. Simon (later Sir John Simon) in 1851 to make a communication between the ureter and the bowel, and the further deliberate effort made by Sir Thomas Smith, who in 1878 did actually in two stages unite both ureters to the colon in one of these cases. But these plans were pioneer work and were not then successful, and the very numerous methods which have been devised and

FIG. 88.—(*a*) A man, *41 years of age*, with a persistent *ectopia, who works regularly* about the mines. (*b*) Twenty years ago, as the result of *nine* operations, the upper part of the exposed bladder was covered by a flap of skin. This enabled him to wear the cumbersome urinal on which he still depends for keeping him reasonably dry during the day. At night he is continuously wet.

tried during the intervening years unfold a wonderful chapter of persevering ingenuity on the part of innumerable surgeons the world over, and great fortitude on the part of countless sufferers. The mere recital of the names of those who are known to have taken part in the work would make a formidable list, and would not by any means indicate the amount of effort expended, for nameless numbers have contributed their quota and masses of animal experimentation have also been carried out.

Briefly the method of Stiles is an intraperitoneal anastomosis of the

ureters into the recto-sigmoid (*Fig.* 89). The operation is carried out through an abdominal incision. About 1½ inches of the ureter are buried in the bowel wall, much after the fashion of the Witzel gastrostomy. The ureters are anastomosed one at a time, with an interval of two or three weeks or more, depending on the recovery from the first interference. Probably there is always some mild renal infection, but that which occurs after the first operation seems to confer some immunity against the severity of any which may occur after the second ureter is transplanted.

The patients soon learn to retain their urine in the rectum, and, in nearly
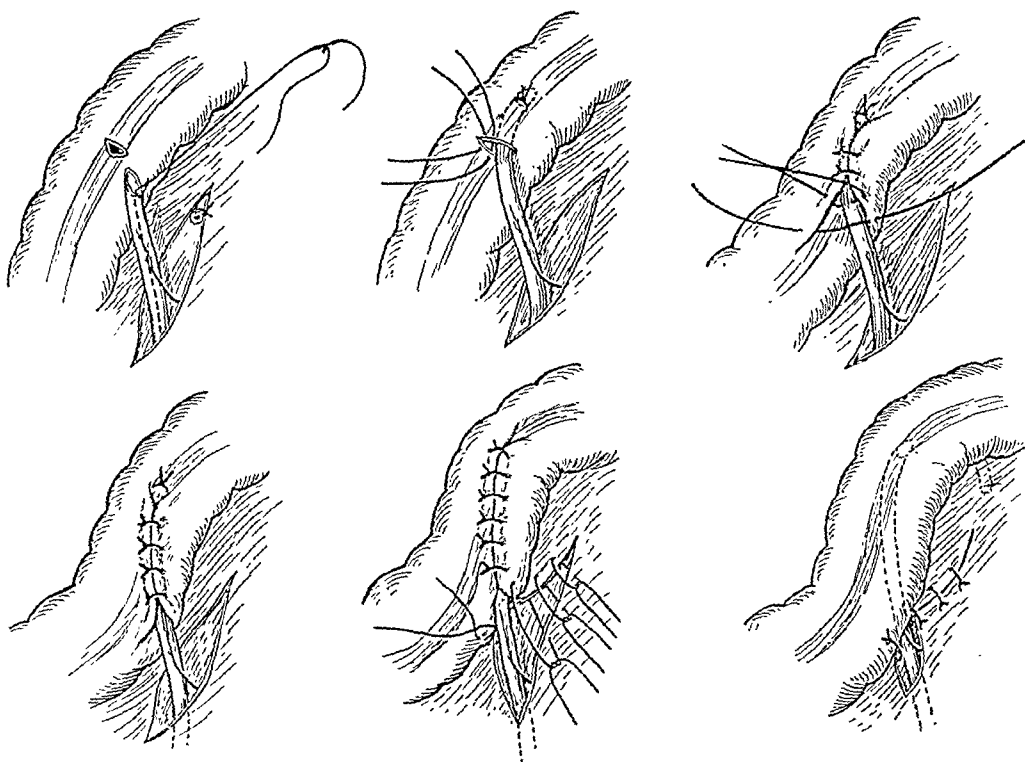
FIG. 89.—Showing implantation of the ureter by the method of Stiles. Note that the ureter is buried obliquely in the bowel wall, and not entirely in the length of the bowel as shown in the original illustrations in Sir Harold Stiles' paper.

all cases, continence becomes complete. When the renal function has become established any necessary plastic operation for the repair of the deformity is carried out.

All but two of my cases have been operated upon by this method, because I recognized that with so rare an abnormality only a few opportunities would occur to any one surgeon, and I thought it better to gain a useful experience in some one method of proved efficiency rather than to try afresh the numerous plans which have been stoutly advocated from time to time.

The congenital defects for which the operation has been carried out have been the various degrees of exstrophy of the bladder and epispadias with incontinence, in both sexes. The frequency of these conditions is difficult

to estimate.　For a very long time the existence of the condition of epispadias in the female was overlooked, and, as effective treatment was not thought possible for that condition in the male when complicated by incontinence, many cases were discouraged from seeking surgical advice.　Although doctors may be in extensive practice for many years without encountering a single case, the experience of all large hospitals shows that a considerable number gravitate to such centres every year.　In the Mayo Clinic, up to the end of 1927, they had treated 115 cases,[3] and at an earlier date, among 367,000 patients seen at the Clinic, there were 69 suffering from exstrophy of the bladder.　The latter deformity is stated to occur once in 50,000 or 30,000 births.　On this basis Lower[4] states that 2,000 examples of the deformity must occur in America every year.　In a paper by C. H. Mayo and William A. Hendricks,[5] the following statement occurs : "Statistics show that 50 per cent of all persons afflicted with exstrophy are dead by their tenth year, and 66·67 per cent are dead by their twentieth year."　From my own personal experience I doubt very much if this is really a natural mortality, and I suspect that if it occurs it is largely the result of neglect.

　　I have watched seven of my patients survive from their earliest infancy and arrive at a stage at which operative measures could be hopefully contemplated.　The mere presence of the deformity in no way interfered with their development, and, except for the annoyance of the incontinence, their upbringing has not been especially difficult, though some of them have been subject to crying fits which have been embarrassing because difficult to explain. No special local treatment has been carried out except that the parts have been kept constantly covered with a greasy cloth to protect the delicate mucous membrane of the exposed bladder from irritation by the napkin.　For this purpose vaseline has been found best.　The children are bathed and otherwise attended to in the ordinary way.　Whenever possible the mothers have been seen at an early stage and have been encouraged to give the same devoted attention to these children as they would to their normal offspring. Only in one case, a baby of less than twelve months, did I observe signs of neglect, and in that particular instance, if the child had been left in charge of the parents, I think it is highly likely that it would have succumbed from this cause.　It was thin and ill-nourished and suffered from prolapse of the rectum, made worse by fits of prolonged crying.　Dr. Dunlop Lickley very kindly admitted the child under his care to the Children's Hospital, and with ordinary attention the baby progressed normally and had no recurrence of the prolapse. Six months later the anal sphincter was perfectly competent, and there was no evidence of unusual laxity of the lower bowel (*Case* 14).

　　In addition to the 17 cases here recorded, I have seen several others who have attained maturity, and in only one, an example of epispadias in the female, in which the patient had reached the age of 26 years, was there any definite evidence of renal infection, and that patient subsequently died at 31 from that cause, no operative interference having been attempted.

　　The principal facts connected with my own series of cases are set out in the following table, and the full details will be found in the notes of the cases which follow.

TRANSPLANTATION OF URETERS FOR CONGENITAL DEFECTS :
CASES AND RESULTS TO END OF 1927.

NO.	INITIALS, SEX	AGE AT OPERATION	DATE OF OPERATION	STAGES	RESULT	YEARS SINCE OPERATION	PRESENT CONDITION	REMARKS
1	F.B., *m.*	8	Dec., 1912	Two	Cure	15	Quite well	
2	E.T., *f.*	22	Dec., 1914	Two	Cure	13	Quite well	Married since operation ; 2 children
3	W.K., *m.*	19	March, 1917	Two	Cure	$10\frac{10}{12}$	Quite well	Slight incontinence at night only
4	E.L., *f.*	20	May, 1917	One	Died			Peritonitis
5	V.K., *f.*	6	Nov., 1917	Two	Cure	$10\frac{2}{12}$	Quite well	
6	J.T., *m.*	13	May, 1919	Two	Died			Peritonitis
7	W.P., *m.*	5	May, 1920	Two	Cure	$7\frac{7}{12}$	Quite well	
8	N.B., *m.*	13	Jan., 1921	One ureter only	Cure	$6\frac{11}{12}$	Quite well	
9	T.L., *m.*	4	Nov., 1921	One	Cure	6		Urinary fistula after plastic on bladder
10	J.F., *m.*	$10\frac{1}{2}$	March, 1922	Two	Cure			Well for 3 years and 3 months, then died from intestinal obstruction
11	E.H., *f.*	$2\frac{5}{12}$	March, 1923	One ureter only	Died			Peritonitis
12	J.P., *m.*	10	Oct., 1924	Two	Cure	$3\frac{2}{12}$	Quite well	
13	W.B., *m.*	4	Sept., 1925	Two	Cure			Well for 2 years and 3 months, then died after plastic on bladder
14	J.M., *f.*	$1\frac{4}{12}$	May, 1926	One ureter only	Died			Septic dermatitis
15	T.L., *m.*	$8\frac{3}{12}$	June, 1926	One ureter only	Cure	$1\frac{5}{12}$	Quite well	Urinary fistula persists (*see Case 9*)
16	J.H., *m.*	3	Oct., 1927	Two	Cure	Recent	Quite well	Kidney decapsulated. Not yet acquired complete rectal continence
17	G.M., *f.*	$3\frac{5}{12}$	Dec., 1927	One ureter only	Cure	Recent	Quite well	Not yet acquired complete rectal continence

NOTE.—In *Case* 17 the second ureter was transplanted in May, 1928, and the patient continues in good health.

Out of the series of 17 cases there have been 4 deaths directly due to the operation. One patient died over three years and another over two

years after operation, and both had enjoyed good health during the intervening period. Of the remaining 11 patients, 1 is included twice for reasons set out in the case record. This leaves 10 patients alive and well at periods varying from fifteen years to seven months since operation.

DETAILED NOTES OF 17 CASES.

In every case the operation was carried out for the relief of incontinence of urine. The age stated is at the time of the first operation.

Case 1.—Total epispadias. Transplantation of both ureters in two stages at seven months interval. Recovery.

F. B., male, 8 years at time of operation. (Reg. Nos. 5249 and 5250.)

HISTORY.—This patient was a rather delicate and under-sized weedy-looking boy, the fifth child among seven born of not very robust parents. Unfortunately no record was kept of his weight or height. He came under observation when 8 years of age, having suffered from incontinence of urine from birth, the result of total epispadias with separation of the symphysis pubes.

FIRST OPERATION, May, 1912.—The right ureter was implanted into the sigmoid, after the method described by Mr. (now Sir) Harold Stiles[2] (*see Fig.* 89). The boy stood the operation quite well, but developed a severe attack of whooping-cough during convalescence, and it was not until seven months later that it was judged the second ureter could be safely transplanted. He had not quite got rid of his cough, and when re-admitted to hospital he was found to be rather thin and white.

SECOND OPERATION, Dec. 6, 1912.—Anæsthesia by open ether. The Trendelenburg posture was used, and the middle line incision re-opened. A little clear fluid was present in the peritoneal cavity. There were only a few flimsy adhesions and the pelvis was easily exposed. The pelvic colon was large and thick-walled, and the rectum was so much distended as to occupy nearly the whole pelvis. The right ureter could be plainly seen lying on the rectal wall and running into it. It was not obscured by adhesions and was securely healed. It was dilated to about twice the normal size, but when vermiculating it appeared to return to its usual size. Many small glands were seen along the line of this ureter as it lay on the rectal wall.

The left ureter, which was normal in size, was implanted into the bowel, a little higher up than its fellow, but by exactly the same technique which had been employed on the right side. The anastomosis made on the left side was a little less oblique than that on the right. At the end of the operation the ureter was noticed to pass from the pelvic wall at more or less of a right angle, and the part above was already a little dilated, suggesting some slight obstruction. In the hope of arresting sexual development half an inch of both vasa were excised in the pelvis and the ends were allowed to retract. The operation occupied about an hour.

PROGRESS.—Immediately after the operation the boy was extremely shocked; he had difficulty in breathing and became very blue. The pulse was irregular and soft. After oxygen and saline infusion the condition improved. The patient had a restless night, but looked much better next day, though the respirations were very rapid. However, he steadily improved, and a fortnight after operation was very well indeed and the wound was quite sound. He required to use the bed-pan six or eight times a day and about twice at night; very seldom had wet beds and then not much. On the sixteenth day he was allowed to return home, where he rapidly acquired good rectal control. His mother made a practice of getting him up to empty the rectum just before she retired for the night and again first thing in the morning. During the day he had no trouble whatever, and went to school and took part in the usual games and mischievous pranks beloved of boys of his own age.

April, 1917 (four years and four months after the completed operation): The boy had kept very well until the previous winter, since when he had suffered from cramp in the stomach, pain in the loins, and weakness of the legs. He looked thin and ill-developed and was too small for his age. The pulse was weak and of poor tension, but he took his food very well. The bowel had to be emptied after every meal and about twice each night. Control was usually good, but there was sometimes a slight accident if he was not able to relieve himself immediately. The evacuation was like dirty water and smelt badly.

In April, 1918, he was just over 14 years of age, and weighed 4 st. 3 lb. 2 oz. By this time his general health was much better and he looked well and was able to run about all

day and sometimes played football. He wanted to begin work as an errand boy, but the firm required a doctor's certificate before they would allow him to start. As a rule he went to bed about 9.30, and was awakened when his parents retired at 10.30 in order that he might empty the rectum. After this he was usually not disturbed again until about 7 a.m. Sometimes he had to get up once during the night, but he never wetted the bed.

In November, 1920, just eight years after the operation, he was aged 16 but still looked small and thin for his years. He then weighed 4 st. 12 lb. 3 oz. The boy was quite well, took food well, and had never been under a doctor since the operation. The rectum was emptied not more than three or four times during the day and at 10.30 p.m., and then not again till 6.30 in the morning, which was the time he had to get up and go to work. As a rule fæces and urine were intimately mixed, but he did occasionally pass a solid evacuation. On the day that he came to the hospital to show himself, after waiting for two and a half hours, he passed 10 oz. of urine. He was then employed as a rivet catcher and earning twenty-five shillings a week. In his spare time he idled exactly as other lads of his own age, and was very fond of playing football. He occasionally suffered from cramp in the bowels and diarrhœa, and lost about two days every month from this cause. The scar of the incision was strong and there was no hernia. The testicles were of normal size and secondary sexual characteristics were developing.

During 1922 this boy kept very well, but was out of work on account of industrial depression. Towards the end of that year he looked thin and poorly, and was found to be developing knock-knee. Both femora were affected, and there was marked down-growth of the internal condyles. When admitted to hospital for the treatment of this condition he was 18 years of age. He was rather anæmic and seedy and there was evidence of generalized rickets, as shown by thickening of the epiphyses and by a marked rickety rosary. He was able to hold his water for five hours without emptying the rectum, never wet the bed, and only occasionally had to get up at night. The evacuation varied a good deal, being sometimes clear like ordinary urine, or a thick, brown mixture, or very rarely a solid stool.

In October, 1922, I operated for the genu valgum, carrying out Macewen's osteotomy on both sides (Reg. No. 14750). The operation was performed under ether anæsthesia, and the patient was kept under its influence for over an hour until the plaster was applied to both sides. Recovery was uninterrupted, and he was able to leave the hospital on the ninth day, not in any way upset by his experience. The ultimate result was very satisfactory, and under supervision and a suitable régime the rickety condition very soon improved.

a	*b*

Fig. 90.—*Case* 1. F. B. Photographs taken 15 years after transplantation of ureters, showing: (*a*) General development; (*b*) Genital development.

In February, 1926, the boy was out of work for a short time with ' lumbago ' and was attended by his family doctor. By June of the same year he again complained, and was put down as *suffering from the same complaint and debility.* Since then he has been attended for ' looseness of the bowels ' and for influenza colds, but has had no further symptoms that could fairly be attributed to his disability. The family doctor informed me that he had only once attended him for an attack in which he suspected ascending renal infection.

In May, 1926, this patient was shown at a meeting of the Association of Physicians. He was then in ordinary good health and made no complaint of any sort. The opportunity was taken to examine the urea content of the urine and blood, with the following result: Urine urea, 0·62 per cent: blood urea, 52 mgrm. per 100 c.c. This examination, therefore, indicated some degree of renal inefficiency. On Dec. 31, 1927, his 24th birthday, he was 5 ft. 4½ in. in height, and weighed 7 st. 9 lb. His general health was quite good and he appeared normal in every respect, but still looked rather thin and not very robust (*Fig.* 90 *a*).

He urinates, per rectum, after breakfast, dinner, and tea, and at bedtime. Sometimes he gets up once in the night if he drinks a large quantity of water, of which he is very fond, but he never wets the bed. The evacuation is usually mixed fæces and urine, but at times he passes a normal stool, and states that he can pass wind without water. The lad smokes about fifteen cigarettes a day. The pelvis is well developed and the pubic bones look normal in the X-ray picture, but they are separated by half an inch and are not on the same level. The lower ends of the femora and upper part of the tibiæ are quite normal. The penis and testicles are well developed, and there is a free growth of hair to the umbilicus (*Fig.* 90 *b*). Occasionally he has experienced an erection and has had nocturnal emissions.

The patient left home about 9 a.m., just after emptying the rectum. About 1 o'clock he had dinner in the hospital, and just after his meal felt as if he wanted to empty the rectum but did not do so. About 1.15 an examination with the sigmoidoscope was carried out. The anus looked normal and grasped the finger firmly. The lower rectum was empty, but when the instrument had entered to about the length of the forefinger, urine commenced to well up into the field from the bowel above, flooding the intrument. In this way about a pint came away and then the boy sat down on a chamber and passed a good deal more. The total evacuation, which was almost entirely urine, was found to measure 29 oz. The rectum and sigmoid appeared normal, and there was really nothing to remark except perhaps a rather unusual moisture of the mucous membrane. A thorough search carried out for about half an hour quite failed to locate the ureteral openings. Indigo-carmine was not used.

Summary.—Case of complete epispadias in the male with total incontinence of urine. Operation at 8 years of age. Transplantation of both ureters into rectum and sigmoid at an interval of seven months. Good recovery. Has enjoyed almost normal health since operation and has engaged in work and play like other boys of his age. In December, 1927, fifteen years after the last operation. he was 24 years old, was quite well, weighed 7 st. 9 lb., was 5 ft. 4½ in. high, and had perfect rectal function and control.

Case 2.—**Epispadias with incontinence. Transplantation of both ureters in two stages at one month interval. Recovery.**

E. T., female, 22 years at time of operation. (Reg. Nos. 7338–7339.)

HISTORY.—This patient was admitted complaining of inability to retain more than a few drops of urine. The condition had existed since birth. At 10 years of age she was admitted to a hospital and examined under chloroform, but was told that nothing could be done to remedy the disability. Between 18 and 19 years of age she was again in hospital on four separate occasions, and had as many local operations carried out. At that time when she was lying on her back she could keep dry for a short time, but as soon as the bladder began to fill it overflowed. When up she was constantly wet. At one of these operations the anterior wall of the bladder was separated from behind the pubes and split from the urethra upwards for an inch. The margins were then sutured together right down into the urethra with the object of diminishing its calibre. At the end of twelve days she went home much improved, having only wet the bed once since the operation, but the improvement was only temporary, and she was soon as incontinent as ever.

When admitted to the Newcastle Infirmary, in November, 1914, she was found to be a good-looking, healthy girl, but shy and sensitive. The underclothing was constantly wet and uncomfortable and she had always a urinous odour. The skin of the thighs was reddened and sore from the irritation. Locally the vulva showed the deformity associated

with epispadias in the female. There were scars of previous operations. The two halves of the pubes could be felt separated to the extent of about an inch.

FIRST OPERATION, Nov. 17, 1914.—Median incision below the umbilicus. The ureter on the right side was exposed and transplanted into the upper rectum by the method of Stiles.

PROGRESS.—The patient went on well until Nov. 26, when the temperature began to rise and she complained of some pain in the right side of the back. There was a trace of albumin in the urine. By the end of a fortnight the temperature and pulse had fallen, the patient was feeling much better and had no pain.

SECOND OPERATION, Dec. 18, 1914.—Just a month after the first operation the abdomen was re-opened. There was some free fluid in the pelvis. The small intestine was adherent to the sigmoid where the ureter had been implanted. These adhesions were separated and the implanted ureter was found distinctly dilated. The left ureter was now anastomosed into the sigmoid in exactly the same manner as the right, but at a slightly higher level in the bowel. The abdomen was closed in layers.

PROGRESS.—After the operation the patient's temperature and pulse were elevated and she had severe pain in her back on both sides. She became a little thin and anæmic. By the end of a fortnight urine could be retained in the rectum for two hours. The wound was perfectly healed and the patient felt much better. She was discharged with full instructions concerning the taking of urotropin, etc.

When she first returned home she lost appetite, complained of weakness and got very thin, and her own doctor said that he thought that she was going into a decline. At the end of February, 1915, she went to the South of England and stayed for some months. The change did her a great deal of good.

Just about a year after the last operation the patient reported by letter that she was very well with the exception of headaches and occasional pain in the back. Her object in writing was to ask advice re marriage. Knowing full well that contrary advice would certainly be disregarded, the patient was informed that there would be some extra risk, but that, if she was anxious to marry, she need not be deterred. She married in November, 1916, and in December reported herself as very well. She still took urotropin and thought it proved beneficial. In April, 1917, this patient asked advice about having children, and elected to take the risk. At this time she reported that the frequency of urination depended upon her general health. When feeling quite well she only emptied the bowel three times a day, and not at all during the night. On the other hand, when not feeling well, she urinated about every two hours by day and about four times each night. Rectal, or rather sphincter, control was very good, and she had only once had a little incontinence after taking some purgative pills. She often had pain across the back, and towards the end of 1917 had often to go to bed for a day or two on that account.

Each year, in December, the anniversary of the operation, she reported on her condition, and at the end of 1918 (the fourth anniversary) the report was very satisfactory. The pains in the back and the headache were often severe, but were always promptly relieved by a few tablets of urotropin. In October, 1919, nearing the fifth anniversary, the patient reported herself as pregnant. There was a good deal of backache, made worse by worry as to the approaching confinement, and as to whether the baby would be similarly affected. The confinement proved to be normal in every way. She was in labour eighteen hours and delivered herself of a healthy child on April 8, 1920. There were no complications in the puerperium, and in July the patient reported herself in better health than ever before, and she was able to nurse her child for twelve months. There was an abundance of milk.

About the time of the sixth anniversary, in December, 1920, the patient came to see me at the Infirmary with her baby. She was looking and feeling very well and able to take ordinary food, and expressed herself as better than ever before, and as delighted with the result of the operation. She supplied the following information as to her daily routine. Her work was to attend to the usual household duties and the care of her child, and also to look after a small confectioner's shop which she and her husband had started to supplement their income. In these duties she got a little help from a young maid. As previously reported, the emptying of the rectum depended a good deal on her general health, but she could go to the ' pictures ' and sit through the performance without discomfort. As a rule she was able to lie all night, but sometimes had to get up as often as four times. She did have pain and discomfort if she wanted to evacuate the rectum and had to wait to do so, but there was never any involuntary escape of rectal contents. There was still a good deal of headache and backache.

In 1921 this patient reported herself pregnant again ; she was very well except for a little bearing down, but was able to continue her work. The second baby was born without the least trouble, and the patient again made an uninterrupted recovery. During 1925 the patient had a good deal of trouble with her ' kidneys ' and was often under the doctor,

especially in the warm weather, when she seemed to be worse ; at such times she had to empty the rectum about every half hour.

On December 29, 1927, she came to report—just thirteen years after the last operation. She was then 35 years of age, measured 5 ft. 1¼ in. in height, and weighed 7 st. 2 lb. Her general health was excellent, and her children of 7½ and 5½ were thriving well. She looked fit and well, and certainly better than at any previous visit (*Fig.* 91). It was especially noticed that her teeth were well preserved. At that time she occupied a house of five rooms in a seaside resort, and ran a business in an industrial town a few miles away. She kept one maid at home and two girls in the shop. Her daily routine begins when she rises at 9 a.m. and empties the bowel before breakfast (takes ordinary food, but has a poor appetite). She then travels by train to her business, where she arrives about 11 a.m., and all day she is occupied in the shop, returning home at 10.49 p.m. Other days the hours are shorter, and one day a week she does not go to business. On Fridays she goes at 9 a.m., and does not return to her own home until Saturday at tea-time. When in normal health she empties the bowel about every three hours, and is able to hold the contents for longer if necessary. At night she gets up once at about 6 a.m., and never has an accident. When not so well, and especially in warm weather, she has to go often during the day, but never more than twice at night.

Nearly always the evacuation is a mixture of fæces and urine. She thinks she passes a lot because she drinks a lot of water. She is able to pass flatus independently of emptying the bowel.

Fig. 91.—*Case* 2. Mrs. A. W. S., age 36, with her children, born 7 years and 5 years after both ureters had been transplanted into the recto-sigmoid. She is now in good health, with perfect rectal function and control, 13 years after operation.

The headaches are not so bad as before ; her eyes have not been tested. Backache is very infrequent now, and only comes on if she gets a little cold or during menstruation. It is always on the right side and lasts not more than a day. The presence of the backache makes no difference to the evacuation.

The menstrual time is regular, but there is a good deal of pain. It is not so bad as before ; her eyes have not been tested. Backache is very infrequent now, and only comes on if she gets a little cold or during menstruation. It is always on the right side and lasts not more than a day. The presence of the backache makes no difference to the evacuation.

On this occasion the bowel was examined by the sigmoidoscope. On request the patient emptied the rectum, voiding 2 oz. of clear urine with a large quantity of mucus. This had collected between 11 a.m. and 1 p.m., and the patient said there would have been much more if she had been drinking as usual. The skin about the anus was normal, and the sphincter was very tight, but not irritable. The mucous membrane of the rectum and sigmoid were unusually moist, but otherwise normal. The opening of one ureter was seen on a ridge : there was no vermiculation and no spurt of urine, only a steady suffusion with very clear water. This was about 8 to 10 in. from the anus. test was not used. The examination of urine resulted as follows : ; albumin, a trace : blood, nil ; urea, 1·5 per cent ; fair amount of mucus ; microscopically, a few pus cells and one or two red corpuscles, triple phosphate crystals, no casts. Blood-urea, 27 mgrm. per 100 c.c. X-ray examination showed that the pubes were curiously pointed and were separated to the extent of $\frac{7}{16}$ in. The pelvis was flat, the greatest breadth being 6⅛ in. The patient did not complain of any difficulty or weakness in walking, and the pubic bones appeared to be firmly held together by a very strong ligament.

Summary.—Case of epispadias in the female with total incontinence. Operation at 22 years of age. Transplantation of both ureters into recto-sigmoid at an interval of one month. Good recovery. Has enjoyed almost normal health since operation. Married, and has had two children born five years and seven years after operation. In December, 1927, thirteen years after operation, the patient is 36 years old and is in better health than ever before ; weighs 7 st. 2 lb., is 5 ft. 1½ in. high, and has perfect rectal function and control.

Case 3.—**Ectopia vesicæ. Transplantation of both ureters in two stages at twenty-four days interval. Plastic on bladder. Prolapse of small intestine through wound causing intestinal obstruction. Recovery.**

W. K., male, 19 years at time of operation. (Reg. Nos. 13708–13711.)

HISTORY.—Patient was one of a family of four brothers and two sisters, who were all healthy. Parents alive and healthy, though the father was alcoholic. The patient himself had never been to school and had only worked about the house. He took regular outdoor exercise, smoked cigarettes to excess, but did not take alcohol. Until three years ago he always lived in the country. Had suffered from measles, but had never had any other illness. Some days felt out of sorts and unfit for exertion. He was a big lad, well built and muscular, but slightly anæmic. The speech was slow and intellect ' simple '. Pulse slow and regular. Locally he presented the typical deformity of ectopia vesicæ, with wide separation of the pubes. No previous treatment had been attempted.

FIRST OPERATION, March 6, 1917.—General anæsthesia. Left ureter implanted to upper rectum by method of Stiles. The vas was exposed at its entrance into the internal ring and severed, the ends being encouraged to retract. The abdomen was closed by interrupted and through-and-through silkworm sutures. The whole operation took one hour. Anæsthetic was taken well, but the abdomen remained fairly rigid throughout. The patient had a little pain and some anæsthetic vomiting, but otherwise made a good recovery.

SECOND OPERATION, March 30, 1917.—The old wound was opened up. The site of the previous anastomosis was found to be surrounded by adhesions of small intestine. At this stage the incision was lengthened about one inch in a downward direction, and it was noticed that a thick fibrous ring was severed round the extroverted bladder. The right ureter was transplanted in a similar manner to the left, but at a lower level. Right vas divided. Abdominal wound closed by through-and-through sutures.

PROGRESS.—The day after the operation the patient had slight cough and much anæsthetic vomiting. The abdomen was tender but not distended. Next day the vomiting and cough persisted and the pulse was quick. On the following morning the patient was still vomiting and complaining of severe pain. The wound was examined and appeared to be normal. At 8.0 p.m. the vomit was noticed to be intestinal in character. The wound was again examined and about three inches of lymph-covered small-intestine and a small piece of omentum were found protruding through its lowest part.

THIRD OPERATION, April 2, 1917.—As the patient refused a general anæsthetic, spinal was employed. This was slow in acting, and he alleged that he never completely lost sensation in his abdominal wall, though he allowed the operation to be completed without interference. The protruding omentum was ligatured and excised. The lymph was removed from the wall of the gut and the latter was reduced by pressure. No attempt was made to close the parietal opening, which was packed and protected by a graduated pad of gauze. After the operation the vomiting ceased and the patient expressed himself as greatly relieved.

PROGRESS.—The next day the patient was doing well, although he still had pain and felt rather sick. From day to day afterwards he steadily improved, and by April 21 he was very well, though obviously a little anæmic. The wound was practically all healed ; there was no evidence of renal infection. He could retain urine in the rectum for two hours and sometimes over three. At night he sometimes evacuated the contents of the rectum during sleep.

By April 27 the patient having revised his opinion of general anæsthesia, another operation was performed under ether.

FOURTH OPERATION.—The bladder mucous membrane was dissected from its bed. Great difficulty was experienced in carrying out this procedure owing to excessive hæmorrhage. Numerous vessels were ligatured, but most of the bleeding took place from cavernous-like tissue existing under the lower part of the mucous membrane. The hæmorrhage having been dealt with, an attempt was made to draw together the two edges of the wound, but this was found to be impracticable owing to the tension of the abdominal wall. Finally the unclosed wound was packed with gauze. The pulse at the end of the operation was 120, and the patient was pale and collapsed from loss of blood,

but quickly recovered with the raising of the foot of the bed. After this anæsthesia he suffered very little from vomiting.

This operation was again well borne, but the next day he had frequent and sudden evacuations. From May 2 he had slight evening rise of temperature, and for a day or two complained of severe pain in the bowels on using the bed-pan. On May 9 he retained his urine for five and a half hours, and by the 19th he was well enough to be discharged to the out-patient department, the wound healing satisfactorily. Inquiries made as to sexual feelings produced a negative reply.

Early in June—that is to say, two months after the second ureter was transplanted —the urine passed per rectum was examined bacteriologically. With the smallest dilution which could be employed the colonies on nutrient media were far too numerous to count. The bacteriological fauna was indescribable, but the prevailing organism was undoubtedly *Bacillus coli.* Urotropin was given for a week, and the examination repeated, but the result was the same, there being no appreciable difference in the number of colonies.

In the beginning of September the patient came to report. He looked very well— better than before operation—and said that he was pleased it was done. He was taking food well, but complained of some pain in the right loin. He passed urine about every two and a half hours during the day and several times each night, and the bed was always wet. The bladder area was now healed except for a granulating area at the root of the penis.

Soon after leaving the infirmary he went to stay with a sister in the country and began to work on a farm, and he has followed this employment, with only occasional interruptions, ever since. In July, 1920, he stated that he habitually worked from 6.30 a.m. till 5 p.m. and often until 7 p.m. During the day he was unable to retain urine for more than one and a half hours without getting wet, and during the night he had to get up three or four times, being awakened by a slight pain in the hypogastrium. The evacuation was nearly always fæces and urine intimately mixed, but occasionally he passed a solid motion. There was no pain in the back or headache, but he suffered very much from thirst. He stated quite definitely that he had no sexual feelings whatever. He voluntarily stated that life was worth living since operation, though it was not worth while before.

In November, 1920, I had an opportunity of examining this patient. He was strong and well and had been working on the farm regularly without trouble. He was then 22 years and 10 months old and weighed 10 st. 6 lb. There was a certain degree of ventral hernia, but this caused him no inconvenience. During the day he emptied the bowel every two and a half hours. At our request he provided a sample of the contents of the rectum ; it was a mixture of urine and fæces, and measured 5½ oz., which had collected in four and a quarter hours. During the night he had to get up once or twice, and had some incontinence, but that was improving. There had been no attacks of pain in the back nor of fever. Sexual feelings were absent, but he did occasionally have an erection. From every point of view he looked on the result of the operation as a great success.

After this time the nocturnal incontinence became worse, and early in 1921 was looked upon as a great nuisance by those with whom he lodged. In March, 1922—i.e., five years after operation—he was seen and was found to be quite well, but not in very good condition, as he had been out of work owing to industrial depression, and had not been getting proper food. During the day he emptied the bowel about every two hours. At night if he slept heavily he had incontinence, but if he awakened to evacuate the bowel this was avoided. About this time he complained of scalding of the anal region, and the skin around was soddened and whitened as if subjected to constant moisture.

In August, 1923, I saw this patient in his first bad attack of renal infection. His mother informed me that up till two months previously he had been splendidly well in every way, and had very often slept all night without incontinence. During the last two months he had been losing ground, became thinner, and was much troubled with cough.

The attack for which I was consulted began on Saturday, July 28. He then felt ill and had pain in the back and vomiting. When seen by Dr. Hammond, of Gateshead, he was found to have a temperature of 104°, and later 105°, but there had been no rigor. At the time of my visit he was very flushed and had a temperature of 101°, and the mouth was dry and parched, but he was perspiring freely and said that he was much better. There was pain in the left kidney region and some acute tenderness behind, but no enlargement of the kidney could be made out. The right side was quite free. During this febrile attack he complained that the urine had escaped from the bowel involuntarily. I ascertained that he had omitted to take his potassium citrate for a considerable time. Without any special treatment he soon made a complete recovery and resumed his work in the country, which he continued without much interruption.

I did not hear from this patient again until July, 1927, when I learned that he was not well, and I went out to the country to see him. I found that he had been out of work a good deal in 1926 owing to the general industrial conditions. He lives with his sister, a married woman in humble circumstances with five children, and I have no doubt that when work is short they often do not get enough to eat. In the beginning of June, 1927, the patient began to complain of pain in the right side of the back and in the right leg, and of weakness and loss of flesh. His sister noticed that he was "hangy" and obviously not well. He felt sickly, though he never vomited. The incontinence at night was very troublesome, and happened occasionally during the day, depending on his general state. In spite of his condition he was able to do a little light work on a farm. I found him rather thin—weight 9 st. 1 lb.—but otherwise looking in fairly good condition, and I observed that his clothes were not particularly smelly. There was no sign of enlargement of either kidney, and he was not tender in the loins. The skin about the anus was again normal. It was obvious that he walked with rather a waddle, but that was always so, and its being worse probably depended on his not very good health. Under treatment with large doses of potassium citrate he quickly improved and gained weight, so that by the beginning of December, when he came to the hospital for a period of observation, he was found to be 10 st. 7 lb., a gain of 20 lb. in about four months. His height was 5 ft. 10 in., and he looked in the robust health of an ordinary countryman, and by this time his only complaint was of the nocturnal incontinence. The local deformity now consists of a total epispadias, but the penis is large and the testicles are well developed. X rays showed a well-developed pelvis with a separation of 3½ in. between the pubic bones.

FIG. 92.—*Case* 3. W. K. The appearance of the ureter as seen with the sigmoido-scope: on the left in the resting state, on the right during vermiculation and after the exhibition of indigo-carmine. The prominence of the internal iliac artery is well seen.

The daily routine he described as follows: He rises at 5 a.m. and goes to the farm, a walk of 2½ miles, to be there by 6.30. Works until 6 p.m. in summer and until dark in winter. In addition to work about the steading he goes to the fields, ploughs, drills, forks hay, etc., etc. He empties the rectum three or four times a day. At night has never acquired continence, and urine escapes involuntarily and he is quite unconscious of the leakage. In spite of this he sometimes passes some urine on first rising in the morning. He is *not* able to void flatus without leakage. The appetite is good and he is able to take any kind of food and in any quantity. The evacuations are as before, and the rectum is of good capacity, for at my request, but with an admitted effort, he retained urine from 6.30 a.m. to 10 a.m. and then passed 18 oz.

He has had a kidney attack nearly every year since the operation. During these attacks he has to remain in bed from a few days to a fortnight, and after that it takes about a week to convalesce. The attacks are now always on the right side. He has pain, fever, and frequent micturition, but never vomits. The skin of the buttocks and the anus now look almost normal, and the latter grasped the finger very well.

A sigmoidoscopic examination was made, and the rectum was emptied just before coming to the theatre. On introducing the instrument the mucous membrane was noticed to be redder than in the other cases examined about the same time. The lower rectum was empty, but on advancing the tube to just beyond the first fold

quite a quantity of urine gushed out—several ounces—as if it had been imprisoned above some valve.

The search for the ureter was not at first successful. The internal iliac artery was noticed to be pulsating very freely and vigorously. Further search revealed one ureter at about this level, i.e., 8 in. from the anus. The ureter hung into the field just like the uvula, and was recognized by the vermicular movements. It moved easily and wobbled about on introducing air with the bellows. The appearance is faithfully represented in the coloured drawing (Fig. 92). The ureter nipple was bright pink in colour, in contrast to the lighter bowel wall. It vermiculated like the normal ureter and was then drawn up a little and became a lighter pink, then relaxed and at times became bright red in colour. Urine could be seen dripping pretty freely from round about the nipple. Indigo-carmine, 4 c.c., was given by intramuscular injection, and in seven minutes the blue urine could be seen escaping in little gushes from the spot at the side of the base of the nipple, as indicated in Fig. 92. So it continued, the effluent getting all the time darker, until at twenty minutes the examination was discontinued. By that time 2 to 2½ oz. of blue urine had been collected. The other ureter could not be found. The one seen was the upper or right ureter, the patient lying on the left side. The examination of the urine collected at this time resulted as follows: Reaction, amphoteric; albumin, trace present; blood, present (pyramidon); urea, 1·50 per cent. The blood-urea from a sample sent on Dec. 15, 1927, was 34 mgrm. per 100 c.c. The lower ends of both forearm bones were examined by X rays and appeared to be normal in every way. Mr. J. S. Arkle kindly examined the fundi for me, but found no evidence of changes in the vessels.

Summary.—Case of ectopia vesicæ in the male with total incontinence, no previous operative treatment having been carried out. Operation at 19 years of age, both ureters being transplanted into the recto-sigmoid at an interval of twenty-four days. Prolapse of small intestine through the wound after the second operation caused intestinal obstruction. Replacement under spinal anæsthesia. A month after the second operation the mucous membrane of the bladder was extirpated, general anæsthesia being employed. Made a good recovery and has been greatly benefited by operation, but has never acquired rectal control at night. Every year since operation has suffered from an attack of renal infection. He has worked fairly regularly as an agricultural labourer. In December, 1927, ten years and two months after the second ureter was transplanted, he was 29 years of age and was quite well; weighed 10 st. 7 lb., was 5 ft. 10 in. high, and had good rectal function and control during the daytime.

Case 4.—Epispadias with total incontinence. Transplantation of both ureters into recto-sigmoid in one stage. Death from peritonitis and pyelonephritis.

E. L., female, age 20. (Reg. No. 13712.)

HISTORY.—This patient was admitted complaining that she had never been able to retain more than a few drops of urine since she was 3 years old. She was found to be well developed and nourished. All the urine had been allowed to soak into the garments and her condition was distressing and pitiable. No previous operation had been attempted. The local condition was that of epispadias as found in the female, the remaining urethra and vaginal wall being patulous and without muscular tone.

OPERATION, April 3, 1917.—General anæsthesia. Middle-line incision from just above the umbilicus to an inch above the pubes. The right ureter was exposed, lifted from its bed, divided, and implanted into the sigmoid by the method of Stiles. In this case the pelvis was roomy and the parts very accessible. The operation had been so easy and looked so satisfactory that it was decided to carry out the same method on the opposite ureter there and then. The left ureter was therefore implanted several inches higher up in the bowel. At this stage it was observed that there was a slight kink in the sigmoid opposite the sacrum, which might at any time give rise to obstruction, so the bowel was adjusted and fixed by some additional sutures. The whole operation occupied sixty-five minutes, the patient being an excellent subject for anæsthesia and the abdominal wall being perfectly flaccid throughout.

PROGRESS.—The patient stood the operation very well, but the next day the pulse was rapid and weak, and the tongue dry, furred, and brown, while the temperature was subnormal. There was no abdominal distension, but much tenderness on palpation. She passed urine per rectum, together with a good deal of blood. On the following day she said that she felt better. The temperature was beginning to rise. Saline and whisky were administered intravenously, with further improvement. On the third day the temperature was 102°, and the pulse still very rapid. There was a severe rigor about middle day, and

in the evening the patient complained of pain over the right kidney. On the seventh day the patient was still very ill, but there were no more rigors. The wound was dressed and found to be satisfactory. Urine was passed frequently per rectum and there were no uræmic symptoms. Large hot foments were applied over both kidneys, and 30 gr. of potassium citrate were administered four-hourly. The patient had a good night and the temperature was slightly better. The next day, the eighth, she complained of more pain over both kidneys and both sides of the abdomen. She felt sick, and complained that she was unable to see clearly. Saline with whisky was injected subcutaneously. The evening temperature and the pulse were both improved, and colour and respiration were better. The pain was lessened but there was still vomiting. The patient had a fair night and slept about five hours in stages, and on the ninth day she looked and felt better. The pulse was as before, but the temperature was subnormal. The same evening the patient had a further rigor, and afterwards she became very cold and breathed badly. From this time the condition steadily became worse, and the patient gradually sank and died just eleven days after the operation.

Post-mortem Examination.—Only a hasty examination could be made. The distended small intestine was adherent over the pelvis, and when separated disclosed a large abscess around the sigmoid in the region of the anastomosis. The left ureter was gangrenous and had separated from the bowel, leaving an aperture the size of a threepenny piece in the gut where the anastomosis had given way. The left kidney was greatly enlarged ; the pelvis contained a large quantity of pus, and there was evidence of ascending infection from medulla to cortex. Microscopically, this kidney showed acute inflammatory change throughout, evidently of septic origin. The right ureter was in position, but the wall of the gut and outer coat of the ureter had both taken part in the inflammatory process. This kidney showed slight congestion, but no marked change in medulla or cortex. Microscopically there was acute parenchymatous inflammation but no evidence of septic invasion.

Case 5.—Ectopia vesicæ. Transplantation of both ureters in two stages at three weeks interval. Perinephritic abscess. Recovery.

V. K., female, age 6 years. (Reg. Nos. 9591 and 9869.)

History.—This patient had been under observation since she was a day old. Her mother gave the baby devoted attention, and she made good progress throughout, thriving like a normal child. When admitted for operation at 6 years of age she was well nourished and in good condition, but very nervous and shy. There was complete ectopia, with cleft of the mons and vulva and wide separation of the pubes.

First Operation. Aug. 28, 1917.—General anæsthesia. Patient placed in Trendelenburg position, mid-line incision. The left ureter was implanted into the rectum by the method of Stiles. Left oöphorectomy also carried out, and the wound closed by through-and-through sutures without drainage.

Progress.—The child stood the operation quite well and seemed very little disturbed. On Sept. 1 there was a little pain in the left side with a rising temperature. By Sept. 4 the pain had disappeared after treatment by the local application of heat. The temperature was down and the patient picking up nicely.

Second Operation, Sept. 18, 1917.—Old incision re-opened. The site of the previous anastomosis was examined and found to be shut off by omental adhesions. An operation similar to the preceding was performed on the right ureter. The gut was made to overlie the exit of the ureter from its retroperitoneal bed. Wound closed by through-and-through sutures without drainage.

Progress.—After this operation the patient picked up well, but there was some vomiting. From the first she used the bed-pan about four times during the night and had no wet beds. About Sept. 28 she developed pain in both kidney regions. The pulse was rapid but the temperature was not elevated. The abdomen became distended ; there was vomiting and some nocturnal incontinence. The patient gradually improved, except that she got steadily thinner and developed a slight evening rise of temperature. She required to use the bed-pan about every two and a half hours. As the condition was not very satisfactory the abdominal wound was opened with sinus forceps and about 10 oz. of pus evacuated. By Nov. 7 the patient was looking better ; there was no pain or discomfort and no more wet beds. There was still a little discharge from the lower end of the wound, and for two days an elevation of temperature.

Operation, Nov. 20, 1917.—Incision again opened up at the lower end, and a further abscess found in the abdominal wall. Under the anæsthetic a mass in front of the right loin was made out, possibly a perinephritic abscess. Another incision was made close to the right iliac crest, evacuating a retroperitoneal collection. A rubber drain was passed through both incisions. By the end of November the child was so much better that the

drains were removed. There had never been any discharge of urine from the incision. Urine was passed every three hours or thereabouts, and there was full continence. A week later the temperature ran up to 102·2° and the pulse to 120. The child had headache and felt sickly. The abscess was practically healed, but the child was still very thin, the condition being attributed to kidney infection. After this the patient gradually improved and was soon able to leave the hospital. She was seen from time to time and steadily improved, so that in due course she was able to go to school.

In November, 1920, she came to hospital for examination. She was then 9 years and 8 months old, and a well-developed, healthy-looking child, able to take ordinary food, and was never sickly. Weight, 4 st. 6 lb. She was attending school and had risen to be a monitor, and was behaving much as other schoolgirls of her age. The rectum was emptied about five or six times in twenty-four hours, four times during the day, and at night about 3 a.m. and again at 7.30 a.m. She awakened and got up herself. Sometimes at night there was a little incontinence, but never by day. On one occasion the urine passed in twenty-four hours was measured, and found to be 33 oz. Once since leaving hospital she had had an attack of pain on the right side, which disappeared in a few hours after the application of hot flannels, and she was all right the next day. Twice or thrice the doctor had attended her for colds or for fainting at school.

In April, 1921, the patient was admitted to hospital in order to have the mucous membrane of the bladder removed. The opportunity was taken of examining the bowel in the hope of inspecting the orifices of the ureters. There were no signs of irritation about the anus and the sphincter was competent. Under general anæsthesia a soft rubber catheter was introduced into the rectum and about half an ounce of clear, odourless urine, mixed with some muco-pus, was withdrawn. The sigmoidoscope was introduced and the bowel distended. The lining membrane of the rectum was seen to be perfectly clean and normal. The two ureteric orifices were found. The one on the right side was very much reddened, and no urine was seen to come from it. That on the left was more clearly seen, and appeared as a small depression in the mucous membrane. There was no hyperæmia in its neighbourhood, and urine was seen coming from it in a series of spurts, which enabled its location to be certainly identified. After this examination the patient was turned on her back and the bladder dissected up from the abdominal wall. There was a good deal of troublesome hæmorrhage. Catgut sutures placed horizontally helped to close the hiatus which remained. The labia were then partially undercut, the incisions being carried well up on to the abdominal wall to relieve the tension. These were then opposed with silk-worm gut. The clitoris was bifid, the vaginal orifice was almost vertical, and was about the size of a normal adult female urethra. It was incised backwards and its mucous membrane stitched to skin. It was very difficult to get the halves of the vulva together on account of the wide separation of the pubes. It could only be done by wide lateral undercutting, and even then there was considerable tension. The patient was under anæsthesia for an hour. She was not unusually upset, and made an uninterrupted recovery from this interference. On this occasion the urine was examined bacteriologically, but the flora was indescribable, and the colonies were much too numerous to count.

In March of 1922 the girl was very well and was developing rapidly, hair commencing to grow on the vulva. Continence was good and she never wet the bed. In 1925, at the age of 14, she began to menstruate normally. Early in 1926 she was better than ever before. In August of the same year the blood-urea was found to be 55 mgrm. per 100 c.c. This definitely raised content in a person of her age was taken by Dr. Spence to indicate some slight impairment of renal function. At this time a further plastic operation was carried out for the restoration of the vulva, the mons being still deeply grooved and somewhat unsightly. General ether anæsthesia was again employed, but the patient was in no way upset and made a normal recovery. During 1926 she had a febrile attack with pain in the right kidney region and was laid up for two weeks. While thus affected she required to empty the rectum more often. In August, 1927, a year later, she was quite well and was able to spend her holidays from home. She then wrote, " When I was younger I could not get away like other girls of my age, but now that I am better I am pleased to say that I can do so. I have spent my holidays in Edinburgh this year and I feel quite well."

In December, 1927, she was splendidly well in every way, and weighed 8 st. 9 lb. and was 5 ft. in height. She looked robust and was bright and cheerful (Figs. 93, 94) and was learning to be a hairdresser ; she left her home at 3 p.m., went a car journey of half an hour, and did not get home until 9.45 p.m. During this time she only emptied the rectum once. In the ordinary way she rises at 8.15 a.m. and empties the rectum, not again until about 12, then at 3, just before going out as a matter of precaution, and after that not until 9 or 10 o'clock. She usually gets up once at night, never more than twice, and never wets the bed. She was not able to say whether she can pass wind, but has not observed and has certainly not been bothered. The opportunity

FIG. 93.—*Case 5.* V. K., at 16 years of age, 10 years and 2 months after operation. Height 5 ft., weight 8 st. 9 lb. The photograph shows the general nutrition and development.
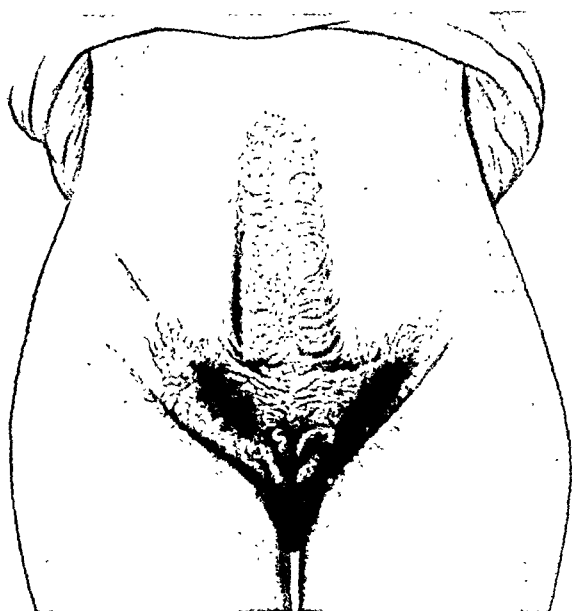
FIG. 94.—*Case 5.* V. K. Drawing made at age of 16, showing the wide abdominal scar and the final result of the plastic operations carried out for the removal of the bladder and the repair of the vulva. Just below the right anterior superior spine is the scar of the incision made for the evacuation of the extraperitoneal abscess which followed the transplantation of the second ureter. There is wide separation of the pubes.

was taken to make a sigmoidoscope examination. The anus was normal and was tightly contracted. The mucous membrane of the bowel looked normal but was moister than usual; no other notable change. Although it was possible to make a careful examination this time the ureteric orifices could not be found, though urine was obviously freely entering the bowel. The evacuation is, as a rule, a mixture of fæces and urine; sometimes clear urine is passed, and very occasionally a solid motion. She walks well without any waddle. The X-ray picture shows wide separation of the pubes.

Her family medical attendant was written to about the febrile attacks, and his reply of Jan. 11, 1928, is as follows: "This patient, before the ureters were implanted into the rectum, used to have acute attacks of abdominal pain. Situation of pain was indefinite —she was of course very young then—attacks used to last from one to two hours, and relief was obtained by placing her in a hot bath. Attacks came on about every two months. After ureters were implanted in rectum she had four or five 'attacks' at about four-monthly intervals. She was shivery and cold, had to be put to bed, and complained of mild, aching pain in her loins. There was tenderness over the kidney region. Poultices were applied to the loins and a diaphoretic mixture given. In three to four days she was quite well."

Summary.—Case of ectopia vesicæ in the female, under observation from birth to the age of 6 years, when operation was carried out. Transplantation of ureters into recto-sigmoid in two stages at an interval of three weeks. Perinephritic abscess opened during convalescence. In December, 1927, ten years after operation, the patient was 16 years old. She weighed 8 st. 9 lb., and was 5 ft. in height. She was well in every way and had perfect rectal function and control.

(NOTE.—In October, 1928, this patient had an unusually bad pain on the right side. X rays disclosed a renal calculus.)

Case 6.—Ectopia vesicæ.   Transplantation of ureters into recto-sigmoid.   Death from peritonitis.

J. T., male, age 13. (Reg. Nos. 11980–11981.)

HISTORY.—This patient was admitted on March 4, 1919, with ectopia vesicæ, with all its discomforts. The boy was in good general condition. No previous operations.

OPERATION, March 14, 1919.—Median incision. Left ureter exposed and transplanted into the sigmoid by the method of Stiles. The ureter was greatly dilated and thin-walled. A portion of the corresponding vas was excised.

PROGRESS.—After operation the patient had a mild attack of pneumonia. He also suffered from very slight diarrhœa, but urine was soon passed per rectum at volition of the patient. By May 13 he was very well; weight 5 st. 11 lb. 7 oz., height 5 ft. 2½ in.

SECOND OPERATION, May 16, 1919.—The right ureter was transplanted into the sigmoid; it was dilated and thin-walled like its fellow. The site of the left anastomosis was obscured by adhesions, but it was observed that the bowel at this point was a little narrowed. A portion of the corresponding vas was also excised.

PROGRESS.—The patient stood the operation splendidly, and was quite well the next morning. The same afternoon blood was noticed in the evacuation. On the second day the patient was not so well and began to vomit a large quantity of dark green fluid. By the third day the boy was very ill. There was frequent vomiting, he complained of pain in the abdomen and on defæcation, and there was some rectal incontinence. There had been some more blood in the evacuation and some bleeding from the wound. On the fourth day the patient had less discomfort, was quiet and free from pain. The temperature was normal, but the pulse was 120–130 and very small and feeble. In the early morning he looked very ill, with sunken face, black nostrils, and cyanosis. The tongue was moist and only slightly coated. There was no distension of the abdomen and no tenderness either in front or in the loins. He suffered from rectal incontinence, but on introducing a catheter through the sphincter about 4 oz. of highly alkaline urine and fæces escaped. Catheter left *in situ* for drainage. At night he was much worse, frequently sick and with a very feeble pulse. Death occurred on the fifth day after operation.

POST-MORTEM EXAMINATION.—An autopsy disclosed general peritonitis, apparently originating in the neighbourhood of the right ureter, which had been transplanted last. A closer examination showed that the ureter had been penetrated by the fixation sutures so that there must have been leakage of urine into the peritoneum. Unfortunately there is no record of the condition of the kidneys.

Case 7.—Complete epispadias with incontinence. Transplantation of ureters into recto-sigmoid in two stages, at one and a half years interval. Recovery.

W. P., male, age 5. (Reg. Nos. 13713 and 13714.)

HISTORY.—This patient was an only child. He was a small delicate baby who only survived owing to the devoted care of an excellent mother. During the first twelve months of his life he was three times in hospital in Leeds, but no operation was carried out. The child was under observation for some time, and as the parents were most anxious to have the operation carried out the first stage was performed at the age of 5½ years, despite the fact that he was small for his age, fair-haired, and delicate.

OPERATION, Aug. 16, 1918.—General anæsthesia. Median incision below and to the right of the umbilicus. The parts were very small, and the great tendency of the intestine to escape from the abdomen was very troublesome. The right ureter was exposed low down and divided, the distal portion being ligatured. Anastomosis into the rectum was carried out by the method of Stiles, about one inch of the ureter being buried in the wall of the gut. The vas on either side was exposed from the pelvis, and divided. The abdominal wall was closed by means of figure-of-eight silkworm sutures. No drainage was provided. A large rubber catheter was passed into the bladder to prevent, if possible, the urine from flowing over the abdominal wound. The operation took about an hour and the boy was rather shocked towards the end.

PROGRESS.—The day after operation the condition was satisfactory. On the 18th and 19th the patient was not so well, being very restless and vomiting frequently. By the 21st the patient had not had the bowels moved, so 1 gr. of calomel was given at night and another on the following morning. That day there was some movement of his bowels. He was still very restless, but there was no vomiting. On the 23rd, just a week after operation, the patient was obviously very ill. It was considered that he had developed some pelvic peritonitis, either the result of retroperitoneal suppuration or of some sloughing of the ureterocolic anastomosis. Under a minimum of anæsthesia the lower sutures in the abdominal wall were removed. As soon as the peritoneal cavity was reached there was a rush of offensive urine followed by pus. Drainage was provided and the boy steadily improved in every way. Pus and urine continued to be discharged from the abdominal wound, but in spite of this he did pass some urine per rectum and he was soon well enough to return home.

After leaving hospital the sinus closed in a few days, and the boy steadily and slowly improved though he continued small and delicate. In February, 1920, he weighed only 2 st. 7 lb. 3 oz. With a view to carrying out the second stage the patient was readmitted in May, 1920. He was still very small for his age, weighing 2 st. 8 lb. 12 oz., and looking frail and delicate.

SECOND OPERATION, May 22, 1920.—The abdomen was re-opened in the mid-line and loops of small bowel were found covered with thin omental adhesions and adherent to the right side of the pelvis, thus obscuring the site of the old anastomosis. The pelvic colon was separated from the pelvic wall and drawn towards the right. The left ureter was then divided about the level of the upper end of the internal iliac artery, and was implanted into the sigmoid by the method of Stiles. There was no tension, the ureter lying comfortably against the bowel wall. This time a small rubber tube was brought from the region of the anastomosis and by a retroperitoneal route through an independent puncture in the left iliac fossa. The abdomen was again closed by figure-of-eight sutures. A large catheter was left in the rectum.

PROGRESS.—For the first three days the condition gave no cause for anxiety, but on the fourth day it was noticed that the patient had developed a rash, slightly papular and with a definite inflammatory edge; there was itching and slight rise of temperature. It was present on the arms, legs, and feet, and a large patch appeared on the forehead. In a couple of days the rash had almost gone, leaving a slight, coppery pigmentation still visible on the limbs. By this time the patient looked very well. The rectal tube was removed and was followed by a good movement of the bowels. By the 29th the rash had completely gone, and the drainage tube was removed from the abdominal wound, which was healthy except for slight irritation round the second top stitch. As far as could be ascertained the boy had rectal incontinence.

On the 31st, that is nine days after the operation, the patient was fairly well but complained of a little pain in the left side and had some temperature and was flushed. Until this he had taken food fairly well, but now he was a little out of sorts and very thirsty. On the 10th day following operation there was some slight urinary leakage from the site of the abdominal drainage tube, and this continued for a week, when it stopped spontaneously. During the next day or two the temperature was up to 101° and the boy was chesty. On June 7 it was noted that the patient had been much better during the previous three days. By June 10 he was well in himself and had a good appetite. Rectal continence was much improved, and he now never wetted the bed during the day, and only about twice at night.

In November, 1920, the report was very satisfactory. The general health was much improved ; he took his food well and always had a good appetite. He was attending a small private school and playing games with the other children. The rectum was emptied about six times during the day and about twice or thrice at night. The boy emptied the rectum when he went to bed about 9 o'clock, and when the parents retired at 11 o'clock he was wakened for this purpose, and again at about 3 a.m. If the intervals were longer than this there might be a slight accident, but not always. At 5 a.m. or thereabouts the boy awakened himself and emptied the bowel, after which he slept in comfort until 8 o'clock when he rose. The parents were delighted with the result of the operation.

In July, 1924, the boy was looking better than ever before. He still had to empty the rectum about twice each night. There was some weakness and a tendency to ventral hernia about the centre of the abdominal scar. In August, 1925, the patient was 12 years of age. The mother reported that for two or three months he had not been so well. Every few days he was seedy and not so lively as usual. There was no shivering or vomiting, but he complained of tenderness in the left loin. When seen he looked very well and was quite plump and a good colour, but there was slight tenderness in the left kidney region, though the organ was not found to be enlarged. Rectal continence was good and the sphincter competent. He was given a teaspoonful of potassium citrate every twenty-four hours, after which the symptoms rapidly disappeared and did not recur. Concerning these attacks, Dr. Stitch reported as follows : " This boy had two febrile attacks with pains in loins and malaise. In the first attack we attended him from May 13, 1925, until May 20. In the second we attended from Aug. 6 to 19, 1925. He has been quite well since so far as we know, and I often see him playing games with other boys, though he is rather quieter and less boisterous than the average boy. I think the latter characteristic is due to a studious nature which has been fostered by his disability." In February, 1926, the boy reported that he was better than ever before.
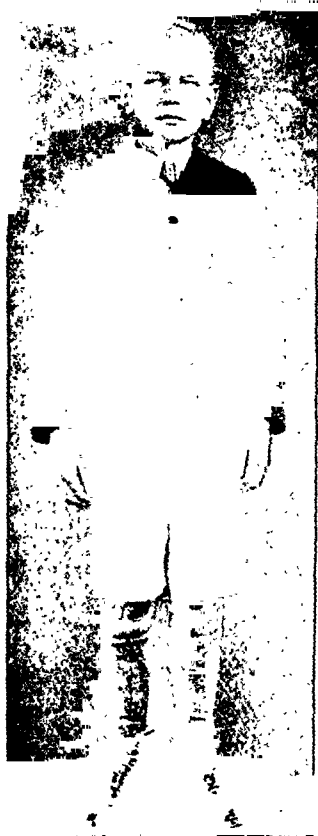
FIG. 95.—*Case 7.* W. P. Photographs at 15 years of age, 7 years after operation. Show good nutrition and development.

On Dec. 16, 1927, seven years after the last operation, he came up for inspection. He was then nearly 15, and was very well in every way and looked well nourished and healthy (*Fig.* 95). He had finished school, having reached the 6th standard, and was attending a Commercial College. He weighed 4 st. 2¾ lb. and measured 4 ft. 2¾ in. in height. The daily routine was much as follows : At 8.30 he rises, empties bowel, and has breakfast. Afterwards comes to Newcastle by train, goes to college, where he sits at his work until 12.45, when he goes to a café, ten minutes' walk, for dinner, and then for the first time since breakfast he empties the bowel. Occasionally during the course of the morning he does go to the lavatory. After dinner he returns to college, where he remains

till 4.15, when he goes a train journey of twelve minutes, then walks home—which takes him five minutes—has tea, and then, or just before, goes to the lavatory again. After tea he goes out to play for a couple of hours and takes part in any game that is going—football, cricket, etc. Afterwards does preparation until supper at 9, after which he evacuates the bowel. He goes to bed about 10, and awakens about thrice in the night to empty the bowel. He states that he can pass flatus independently of emptying the rectum and that there is never an accident. The evacuation is always urine and liquid fæces intimately mixed. Never voids a solid motion. The anus and sphincter are quite normal. Sigmoidoscope examination was not made as the boy was rather nervous about it. The evacuation contained 3 gr. of urea to the ounce. He sometimes gets pain in the left side, but only very seldom—about twice in the last two years. No tenderness or enlargement of the left kidney—i.e., where he has had the pain. The testicles are descended and well developed. X rays show a normal-looking pelvis except that the pubic bones are separated to the extent of 1½ in.

Summary.—Case of complete epispadias with total incontinence of urine in a very delicate type of boy. Operation at 5 years and 6½ years respectively. Long interval on account of pelvic infection with urinary fistula after the first stage. Since second operation has steadily improved in health and has been able to attend school, where he has done very well. Three years after operation had some attacks of renal infection which readily yielded to treatment. In December, 1927, seven years after operation, he was nearly 15 years of age, in splendid health, and with perfect rectal function and control.

Case 8.—**Total epispadias with incontinence. Transplantation of one ureter into rectum. Recovery.**

N. B., male, age 13. (Reg. No. 13489.)

HISTORY.—Patient complains that he cannot hold his water at all, and that " he wets his bed and his trousers." Has had this trouble ever since he was born. He states that he had pneumonia when he was 10 years old.

ON EXAMINATION. — Condition of epispadias with dorsal cleft down to pubes, the mucous membrane being exposed in the entire penile portion of the urethra. A forefinger can be introduced easily into the bladder. The patient has almost complete incontinence when up and about, but not marked when lying in bed. His clothes were constantly wet, smelly, and encrusted with phosphates. He was undersized, very anæmic, precocious, and apparently in good general health. No obvious cause for the anæmia was detected. For a week he was kept under observation, and as he appeared to be all right it was decided to operate.

OPERATION, Jan. 22, 1921.—Median incision above and below the umbilicus. The left ureter was exposed above the brim of the pelvis and divided, the proximal end being transplanted into the upper rectum by the method of Stiles. There was a small hæmatoma below the anas-

FIG. 96. *Case 8.* N. B. At 13 years of age he was completely incontinent. One ureter was implanted into the recto-sigmoid. Since that operation he has acquired continence and urinary control. Since this photograph was taken the local deformity has been repaired, and he now only presents a slightly bifid glans.

tomosis which was opened and the clot turned out. A fine rubber tube was brought through a separate opening from the site of the anastomosis.

PROGRESS.—Jan. 25 : No abdominal symptoms. Had a high temperature and quick pulse and was very tender over the left kidney. Jan. 31 : The boy was much better ; he still had a fitful high temperature, but was not tender in the left loin. Bad cough. Feb. 1 :

Patient's temperature continued ; tube removed. Feb. 6 : Wound healed ; never been any leakage. Feb. 7 : Definite tubular breathing and increased vocal resonance in the upper part of his left lower lobe. Dr. W. E. Hume reported massive collapse of the base of the left lung. March 19 : Boy generally very well, up and about and active. The incontinence not nearly as bad as before, and could fairly be described as halved. The left chest had not yet recovered ; there was still some collapse, and at the apex there was an area of localized crepitations, which Dr. Hume thought was evidence of tuberculosis. The spleen was palpable. Further operation was postponed.

Jan. 8, 1928 : This was the first time this boy had been seen or heard of since the operation. He is now big and strong, age 19 years, weighs 8 st. 9 lb. and is 5 ft. 4½ in. high. Plays football vigorously. He has a big appetite and eats one stone of bread a week. Says that now and for some years he has not suffered from incontinence. He has control over the act of micturition and passes urine like other men (his father says the water splutters about). The lad's statement was borne out by the fact that his shirt and other clothing were quite dry, and by his mother, who stated that his bed was never wet. Only empties rectum four times daily. Evacuation is always liquid. Penis very large and testicles well developed (*Fig.* 96). Recently had bad attack of pneumonia. The urine passed per urethram contains 1·8 per cent of urea ; that per rectum 0·5 per cent. When examined with the sigmoidoscope the rectum looked normal ; there was very little urine in the lower part, but it welled into the instrument from above the folds of Houston. The ureteric orifice could not be found.

A plastic operation was carried out for the closure of the urethra. This was satisfactory except for the region of the glans, where there was a little loss of tissue by sloughing. The patient was not in the least upset by this interference, and showed no evidence of renal abnormality while in the hospital.

Cases 9 and 15.—Ectopia vesicæ. Transplantation of ureters by Peters' method in one stage, Good recovery. Further operation for removal of mucous membrane of bladder. Transplantation of left ureter by method of Stiles. Recovery.

T. L., male, age 4 years 2 months. (Reg. Nos. 14199–17328.)

HISTORY.—The boy, the second child of healthy parents, was born with complete ectopia vesicæ. He was carefully looked after as a baby and throve well. When admitted to hospital he was found to be well developed in every way except for the local deformity. Wide separation of the pubes was very striking. There was no evidence of renal sepsis. The mucous membrane of the bladder presented an extraordinary villous condition, making it look like a tumour ; this condition only effected the parts above the trigone ; the latter was not involved, but was obscured by the overgrowth of villous processes from above. It was decided to carry out the Peters operation as being less dangerous in a child of this age.

OPERATION, Nov. 22, 1921.—General anæsthesia, open ether. The ureters were found with ease, and a No. 6 Jaques catheter, with the end cut off, was passed into each. Urine flowed freely from the left side, but none came from the right. The separation of the ureters from the bladder wall was difficult because the parts were overhung by the villous processes, and because of the free bleeding. Eventually about 1½ in. of each ureter were separated with a rosette of bladder wall round the orifice. The catheters were fixed to either ureter with a fine catgut suture. With a finger in the rectum the anterior wall of the latter was pushed forward and was divided transversely without opening the peritoneum. The ends of the ureters, with their catheters, were then turned into the rectum, the catheters being brought out of the anus. The incision in the rectal wall was drawn together with two or three interrupted catgut stitches, the ureters traversing the bowel at either extremity of the transverse incision. The operation took about half an hour and was well borne.

PROGRESS.—This was uninterrupted. There were never any bad symptoms, and nothing to suggest renal infection The bowels moved naturally, and there was no fæcal leak from the incision in the posterior bladder wall. There was never any flow of urine from the catheter on the right side, and on the 27th it came out of its own accord ; on the 28th its fellow, which had discharged freely, also slipped out. The child continued to do well, and left hospital on Dec. 13.

From the first this patient began to develop rectal control, but it was not complete, and he was always more or less wet at night. By January, 1922, his mother was able to report " the control in the daytime is now growing quite good, and there is no need to take any precautions other than continual watching and reminding. At times he can hold for three hours, his best days, at others every hour, but during the night we have not been so successful. Nevertheless, we do feel that he is making good progress in this respect." His appetite continues good, and there has been no sickness, but the boy seems very frail."

This patient was brought to see me on Oct. 19, 1922, because his father thought he

dragged the right leg more than he ought to do. I found just a little weakness of the leg, but nothing to cause the slightest concern. The boy appeared to me to be perfectly well, and his mother tells me that he sleeps and eats quite naturally. In the daytime he has perfect control. Not only so, but he can, if necessary, wait as long as twenty minutes in spite of an urgent desire to clear the bowel. The fæces and urine are sometimes mixed, but often passed alternately. At night time there is occasionally a little incontinence, but it is not bad. About every six weeks he gets some sort of attack, which may be associated with renal infection, but his mother tells me that he is never tender in the loins, and that he never vomits. Both the nurse and the mother informed me that when he has one of these so-called 'attacks' they notice a peculiar smell which is at times offensive. The exposed mucous membrane of the bladder gives him no trouble, and it was not proposed at the moment to interfere with it.

In November, 1923, the attacks were more troublesome, and were described as follows by his nurse : " Sickness, limp and tired, loss of appetite, temperature high, rapid pulse, dark rings round eyes, face pale ; occurring every ten days to a fortnight. Complains of pain in left hip ; always drags right foot. Sickness immediately after food, and is always hungry after sickness. Passes undigested food in motions ; colour yellow and sometimes greyish yellow. Urine sometimes highly coloured and rather offensive. Granulations (i.e., exposed bladder mucous membrane) sometimes very inflamed and sometimes almost white. Incontinent when sleeping during attacks, but at other times perfectly all right. Rectum emptied about five times each day. There is some offensive discharge from the bladder area." When seen he was looking thin and white, but the general nutrition was fair. Walks rather badly owing to wide pelvis. In December, 1923, he had rather a bad attack, but he soon picked up, gained weight, and was in wonderful spirits. During 1924 he had several attacks, but in July he was a good deal better, and weighed 3 st. 7 lb. By January, 1925, he was very fit on the whole, though still slightly feverish at times. Has had much better control during the last few weeks. He was seen in February, 1925, looking very well, though nervous.

Later, in September, 1925, it was decided to remove the mucous membrane of the bladder. For this purpose he had a general anæsthetic. The operation (Reg. No. 16910) took three-quarters of an hour. It was borne well, and there were no unusual features as far as the anæsthetic was concerned. The boy did not empty the rectum while going under the anæsthetic, but 2½ oz. of urine were drawn off at the beginning of the operation and 1¼ oz. at the end—i.e., the latter had accumulated during three-quarters of an hour. This specimen was clear except for masses of floating mucus. It smelt strongly ammoniacal and was very alkaline to litmus paper ; specific gravity 1012 ; only a faint trace of albumin ; no sugar ; urea 1·3 per cent. Bacteriologically the prevailing organisms were streptococci and bacilli of Morgan No. 1 type.

The skin about the anus was natural in appearance, and the sphincter as judged by resistance to the finger, and the rectum as seen by the sigmoidoscope, seemed normal. The latter was certainly not unduly dilated. The ureters were felt on the anterior wall 1½ in. from the anus. They were like two raised nodules in the midst, or rather on the surface, of an area of firm scar tissue. Seen with the sigmoidoscope they were paler than the mucous membrane of the rectum and just like two rosettes, and from time to time urine was seen to be ejected from the slit-like orifice on the summit of the left.

At this operation tenotomy of the right tendo Achillis was first carried out, and this was followed by excision of the mucous membrane of the bladder. The latter step was not difficult, but several vessels required ligature and bleeding obscured the field. The recti muscles could not be drawn together and the skin only to a slight extent. The testicles were noted to be both in the scrotum.

PROGRESS.—The boy did not appear to be upset by this interference, but when the gauze was removed from the bladder area it was noticed to be wet with urine, and it was soon obvious that there was a leak, a communication having been established with the rectum. An attempt was made to close this by suture on Oct. 10, the patient being under an anæsthetic for about twenty minutes. After this interference he had pyrexia, the temperature rising to 103°, and he was upset, but there were no symptoms to cause alarm.

The leakage continued, and on Nov. 4 another operation was carried out. A hole was found leading into the rectum which would admit the tip of the little finger, and into this hole the left ureter was prolapsed. Its open mouth was seen like a rosette at the upper margin—i.e., external aspect—of the hole, and from this urine freely escaped. The ureter was drawn into the rectum and fixed there by sutures, the hole in the rectum being drawn together. The closure looked satisfactory, but on Nov. 8 there was again obvious leakage.

On Nov. 18, under anæsthesia, a No. 6 rubber catheter was passed into the orifice of the left ureter, which had again prolapsed into the aperture, and about two drachms of almost pure pus were drawn off. The catheter was brought out of the anus and the hole in the rectum closed. The kidney was irrigated daily through the catheter. There was very

little reaction, and the boy continued to take food, etc., as usual. When the catheter came out at the end of a week it was obvious that the fistula was not healed, and the urinary leakage recurred.

In March, 1926, the bladder mucous membrane round the fistula was touched with the electric cautery. From this time onwards practically all the urine escaped from the fistula, and from time to time there was some fæcal discharge. He required to be changed two-hourly. His general condition remained quite satisfactory. In July, 1926, it was decided to transplant the left ureter into the sigmoid, the boy being in very good condition except for the urinary fistula.

OPERATION, June 12, 1926 (Reg. No. 17328).—The patient was passing an abundance of urine which could not be measured. Samples contained 10 gr. of urea to the ounce. Blood-urea was slightly increased, 36 mgrm. per 100 c.c., indicating some renal inefficiency. General anæsthesia, Trendelenburg position. The left ureter was found to be enormously distended, and looked like a piece of small intestine. An attempt was made to implant it into the bowel by the method of Stiles, but it could not be buried in the gut without using an inordinate amount of the latter for the 'tuck in'. It was, therefore, only buried at the point of anastomosis, and the latter was protected by stitching neighbouring appendices epiploicæ over the site. A rubber tube was brought from the neighbourhood of the anastomosis out through the parietal wound. Both kidneys were felt to be small, and the right ureter was about the same size as the left, but it was not interferred with. The incision was closed with figure-of-eight silkworm. The operation took just under one hour. The boy stood the interference very well, and suffered no immediate ill effects. On the 8th day he had a definite kidney reaction, with temperature up to 101°, sickness, and tenderness in the left loin. This soon passed off and he was able to leave hospital three weeks after the operation.

Unfortunately the urinary leakage continued much as before, and from time to time there was an escape of fæcal matter from the bladder fistula. By the early part of September his general condition was excellent, he was very active, and was taking his food well, though the local condition was very little altered. About the middle of this month he had a very severe renal attack, which came on quite suddenly and greatly alarmed his parents and medical man. It began with a rigor, the temperature running up to 103° with corresponding quick pulse. He was sickly, restless, and very thirsty. The urine was thick and very offensive, and contained much pus. He also had diarrhœa, and was very tender in the left loin. By the end of the month his condition was apparently normal again, but he had lost a good deal of weight and was white and pinched. This was the most severe attack from which he had ever suffered.

By December, 1926, he was about himself again ; he had a good appetite and was regaining strength. He rides a bicycle, and has a companion with whom he plays and does lessons. There was perhaps a little less urinary leakage. The parents were averse to any further operation at that time, and in October, 1927, he was fitted with a urinal which kept him more comfortable during the day. Generally he was surprisingly fit and well.

Case 10.—**Total epispadias with incontinence. Transplatation of both ureters in two stages. Recovery. Intestinal obstruction three years later. Death from peritonitis.**

J. F., male, age 10¼ years at the time of operation. (Reg. No. 14482.)

HISTORY.—The patient was admitted to the hospital on March 19, 1922. He had suffered from incontinence of urine, with all its disagreeable consequences, since birth. His education had been very seriously retarded. Apart from an attack of measles at the age of four years, and of scarlatina some few months prior to admission, there was nothing of importance in the past history. He was, however, said to have ' never been very strong '.

ON EXAMINATION.—The general health appeared to be fairly good. Locally there was a condition of complete epispadias, and the resulting incontinence had caused excoriation of the skin over the lower abdomen and scrotum. The child's general health and the fact that he had successfully weathered the storms of the acute exanthemata showed a good resistance.

FIRST OPERATION, March 22, 1922.—General anæsthesia. Mid-line incision. The left ureter was approached by the transperitoneal route, mobilized, and after division low in the pelvis was transplanted into the sigmoid colon after the manner recommended by Stiles. A small rubber drainage tube was placed down to the region of the anastomosis ; in addition a short tube was passed through the anus into the rectum to prevent distension. The child stood the immediate effect of the operation very well. It was followed by a fairly vigorous renal reaction as evidenced by the temperature, which reached its highest point, 100·8°, on April 4, with tenderness over the left kidney.

SECOND OPERATION, April 22, 1922.—General anæsthesia was again employed and the

old incision re-opened. The right ureter was implanted by a similar procedure into the sigmoid, drainage being employed as before. In addition it was observed that : (1) The previous anastomosis was well protected by the parietal peritoneum having been sutured over it ; (2) The left ureter could be felt in the bowel wall as a thickening, reminiscent of rectal polypus ; (3) The rectum appeared to be more distended and hypertrophied than at the previous operation ; (4) On opening the bowel after the application of the clamp, clear urine escaped. A good recovery was made from this operation, but a definite attack of renal infection again occurred, with some night fever up to 100·4°, which continued until May 1.
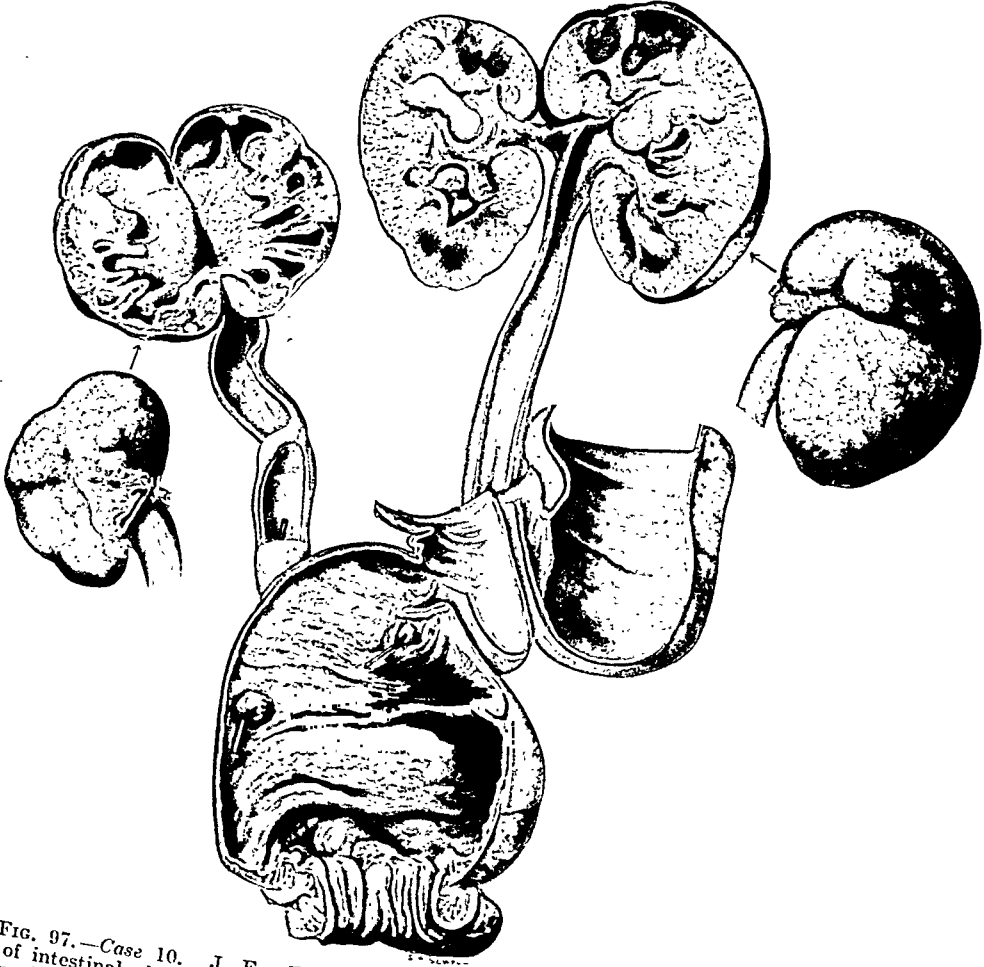
FIG. 97.—*Case* 10. J. F. The parts obtained after death from this patient, who died of intestinal obstruction 3 years and 3 months after implantation of both ureters. Intermediate health had been excellent. The right ureter is nearest the anus. The whole rectum is dilated, its wall is a little hypertrophied and the mucous membrane is covered with an inflammatory exudate which gives it a roughened shaggy appearance. Above the level of the ureteric orifices the surface appears normal.

On May 9, 25 oz. of urine were being passed from the rectum per diem. This urine had a specific gravity of 1010, a thick, dirty yellow appearance, a ropy deposit, an ammoniacal smell, and an alkaline reaction. On May 11, the entry in the hospital notes reads thus : "The patient is bright and happy. He passes urine per rectum with perfect continence about four times a day, and his bowels move comfortably about three times a day. The motion is a fluid one. His temperature and pulse are normal. He sleeps and eats well, and states that he feels better than ever he has done before. His abdominal wound is

healed perfectly and there is no sign of skin irritation left over the lower abdomen and scrotum." Urine from the rectum contained $4\frac{1}{2}$ gr. of urea per ounce, i.e., 1·4 per cent. On May 16 he was discharged.

He remained perfectly well until May, 1925—three years later—when he was re-admitted with a history that during the previous twenty-four hours he had been suffering from recurring attacks of colic. Up to this time he had been attending school regularly, playing with the other boys, and taking food well—in fact, he appeared in every way normal. When seen in the hospital the boy was found to be in very good condition, and nothing abnormal was discovered on physical examination. The possibility of the attacks being renal in origin was at first considered, but the boy appeared to be perfectly well, the temperature was not elevated, there was no tenderness in the loins, and no palpable enlargement of either kidney. After two days, there being no recurrence of the pain, he was allowed to go home. A few days later, however, he was re-admitted, looking very ill and with evident signs of intestinal obstruction, with copious fæculent vomiting. The abdomen was opened by a junior colleague and the condition found to be an acute obstruction of the small intestine due to a band in association with tuberculous mesenteric glands.
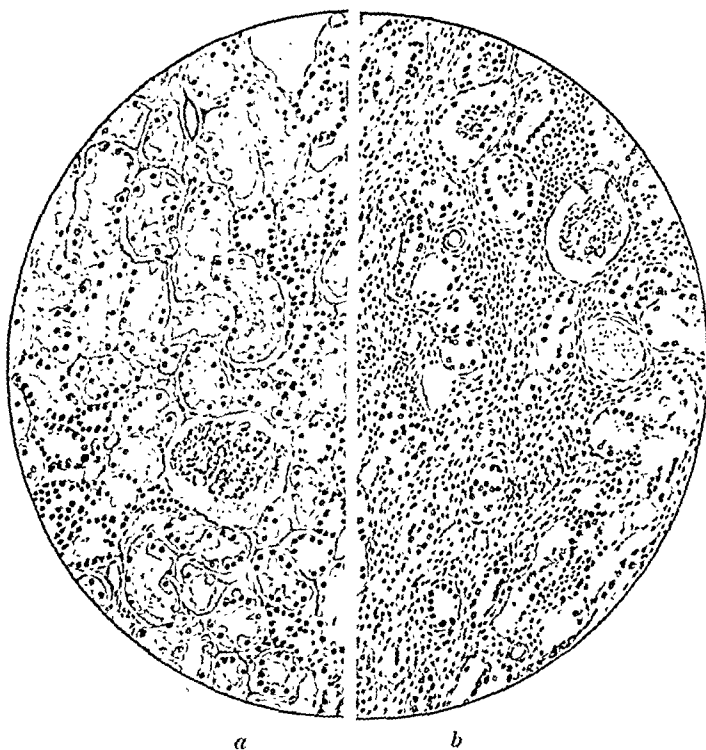
FIG. 98.—Microscopic sections of (*a*) left kidney and (*b*) right kidney. (× 86.)

It was necessary to make a lateral anastomosis. At the end of the operation there was a marked degree of collapse, but this was speedily overcome and for a couple of days recovery seemed assured. At the end of this time symptoms of peritonitis developed and the condition rapidly progressed, death occurring on the fifth day.

POST-MORTEM EXAMINATION.—There was a suppurative peritonitis binding the coils of intestine together. Some of the sutures at the anastomosis had given way and fæcal matter had escaped. The mesenteric glands were distinctly enlarged and caseous, some being definitely calcareous.

An examination of the recto-uro-genital organs resulted as follows (*Fig. 97*):—

The *rectum* was distended and its muscle definitely hypertrophied. The mucosa below the level of the ureteric orifices was coated by a shaggy exudate, and microscopically this region was found to be the seat of a mild catarrhal inflammation, whilst above this level the mucous membrane was smooth and appeared healthy both on naked-eye and microscopic examination. This slight degree of catarrhal inflammation could probably be

explained by the irritation consequent on ammoniacal decomposition of the urine. The right ureteric orifice was patulous, its mucosa having prolapsed, giving it a button-like appearance. Its wall showed a similar inflammatory change to that seen in the neighbouring rectal mucosa. The left ureteric orifice was very difficult to find, and was represented by a mere slit through which only a fine bristle could be passed. contrasting with its fellow, which admitted with ease a glass rod of much greater magnitude. The orifice of the left ureter could only be demonstrated by injecting fluid into the ureter above and searching for the issuing stream.

The *right kidney* was markedly shrunken and its surface deeply scarred. On section the organ consisted mainly of the dilated pelvis and calices. The condition was an advanced pyelonephritis. Microscopic examination (*Fig.* 98 *a*) of such renal tissue as remained showed extensive fibrosis, hyaline changes, and round-cell infiltration in the glomerular region. The tubules showed cloudy swelling. Areas of necrosis with accumulation of polymorphonuclears were also present, and in these there were a few bacteria.

The *left kidney* was of normal size. Its surface was also somewhat scarred. In the section some of the pyramids were much darker than the cortex. The cortex was swollen and the vascular markings stood out prominently. The pelvis and calices were slightly distended, the former merging imperceptibly with the ureter. Histologically (*Fig.* 98 *b*), the cortex showed areas in which some of the glomeruli were fibrosed, others showed slight lobulation, and in addition there was a round-celled infiltration. The tubules showed little change apart from cloudy swelling. The areas of fibrosis represented healing after a previous acute nephritis, probably a ' flare up ' after the transplantation operation. The appearances indicated the presence of a subacute inflammation of the kidney probably of the nature of an ascending pyelonephritis. A considerable number of fields exhibited relatively normal renal tissue. It is possible that the areas of necrosis containing bacilli, etc., seen in the right kidney represented a terminal pyæmic process, a consequence of the septic peritonitis.

The *ureters* when opened contained a quantity of purulent fluid. Both of them were dilated, but the wall of the right was the thicker. The right ureter was also shorter and more tortuous, and about its middle there was a definite annular narrowing. Histologically there was evidence of ureteric infection.

Summary.—A case of total epispadias with incontinence. Operation at $10\frac{1}{2}$ years of age. Transplantation of both ureters into recto-sigmoid at an interval of a month. Good recovery, and health with normal rectal function and control for three years. Death from peritonitis following an operation for acute intestinal obstruction. Right kidney in condition of pyonephrosis, the left showing evidence of recovered pyelonephritis.

Case 11.—Ectopia vesicæ. Transplantation of one ureter. Death from peritonitis.

E. H., female, age 2 years 7 months. (Reg. No. 15301.)

HISTORY.—This baby was a healthy child with typical complete ectopia. It had been under observation since it was a few days old and had thriven very well.

OPERATION, April 7, 1923.—Combined spinal and general anæsthesia. Trendelenburg posture. The intestine did not tend to prolapse. The left ureter was found very much dilated and full of urine ; it vermiculated freely. Peritoneum over it divided and about 2 in. of ureter mobilized. It was divided just above the bladder, and the distal end was allowed to retract into the retroperitoneal space. During this stage some urine from the upper end of the dilated ureter escaped into the peritoneum. The anastomosis to the bowel was made by the method of Stiles, great care being taken not to compress the ureter, and not to perforate the wall with the fixation sutures. The big ureter took up a good deal of bowel for the tucking-in process, and rather narrowed it in consequence. A tube was brought from the site of anastomosis to the outside.

The child stood the operation well, and recovered from the immediate effects without incident, but afterwards she never appeared to be quite right. The day following the operation, and for several days, she vomited continuously and looked very ill. Death occurred on the ninth day.

POST-MORTEM EXAMINATION (notes very poor).—General peritonitis involving infracolic area of the peritoneal cavity. This appeared to come from the wound. The junction between the ureter and the colon was intact. The pelvis of the left kidney was dilated and filled with purulent urine. There was extreme pallor of the renal tissue, but no obvious pyelonephritis. On microscopic examination the capsule was found to be definitely thickened and there was a moderate degree of chronic venous congestion. Irregularly scattered throughout the cortex, but more particularly in between the collecting tubules, there was an inflammatory cellular infiltration, the cells in which were chiefly

of mononuclear type. There were a few foci of inflammatory change due to abscesses which were undergoing repair. The infection appeared to be of ascending type. The right kidney showed marked dilatation of pelvis and ureter, but without infection.

Summary.—Case of ectopia vesicæ in a healthy child of 2 years and 7 months. Death from peritonitis after transplantation of one ureter. The infection appeared to arise in the region of the abdominal incision. The kidney on the transplanted side showed very definite ascending pyelonephritis.

*Case 12.—***Ectopia vesicæ. Transplantation of both ureters in two stages at three weeks interval. Recovery.**

J. P., male, age 10 at time of operation. (Reg. Nos. 16250–16251.)

HISTORY.—The patient was the second child of a family of three, the parents not being very robust. On admission he looked thin and weedy, but seemed healthy enough and took food well. Weight 3 st. 2 lb. 9 oz. The ectopia was complete but there was no hernia. The pubic bones were widely separated (*Fig.* 99).
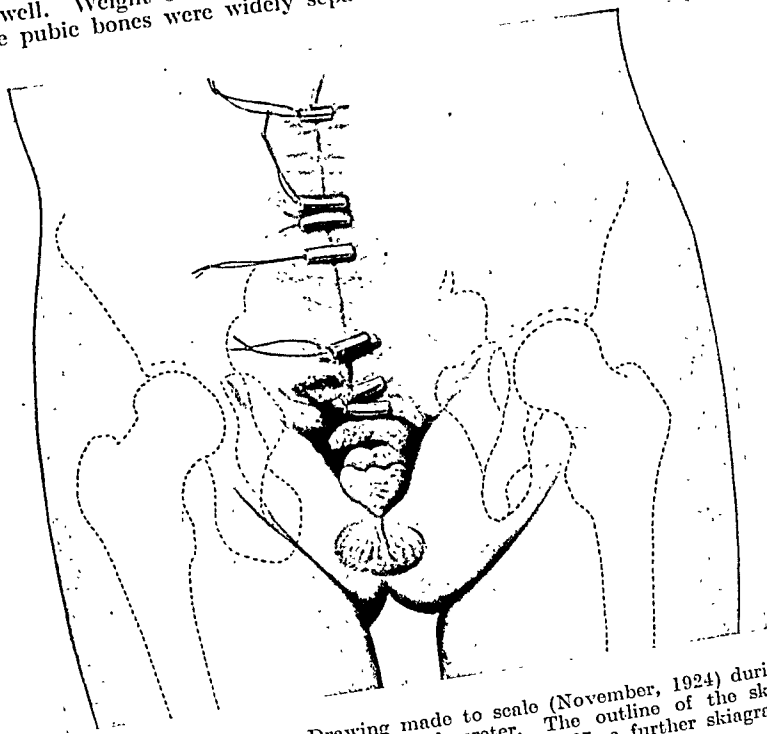
FIG. 99.—*Case* 12. J. P. Drawing made to scale (November, 1924) during convalescence from transplantation of the second ureter. The outline of the skiagram of the bony pelvis has been superimposed. In December, 1927, a further skiagram showed the same wide separation of the pubes.

FIRST OPERATION, Oct. 7, 1924.—General anæsthesia. Mid-line incision. Trendelenburg posture. Left ureter first dealt with. It was ligatured and divided close to the bladder, and the lower end carbolized and allowed to retract. About 1½ in. of ureter were buried in the bowel by the method of Stiles, and the region of anastomosis was fixed to the edge of the pelvic peritoneum by suture. A small drainage tube was brought from the neighbourhood of the anastomosis through the parietal incision. The operation took about one hour and was well borne.

PROGRESS.—This patient was very well, and there were no special symptoms, and certainly no cause for anxiety, until the morning of Oct. 9, i.e., two days after the operation. On this day he became suddenly ill, there was severe collapse with pale bluish lips, cold, clammy surface, and feeble pulse. The ward sister, an experienced nurse, thought that he might be going to die, and the house surgeon feared some internal hæmorrhage. The boy did not vomit, but felt sick. There was no complaint of pain. When seen by the author a diagnosis of left renal infection was made. The wound was dressed, and a

small tag of omentum was found prolapsed through the upper end, but this was not recent. The attack soon passed off and his condition steadily improved. By the 13th he was taking abundant liquid nourishment. Citrate of potassium in 15-gr. doses was given thrice daily. At first the emptying of the rectum was involuntary, but by this date he was developing control and asked for the bed-pan frequently. There was never any leakage from the abdominal drainage tube, and it was removed on the twelfth day. By the 26th the boy was very well in every way.

SECOND OPERATION, Oct. 28.—General anæsthesia. Abdominal incision re-opened. There were some few adhesions to the back of the incision. The lowest part of the sigmoid was closely adherent to the wall of the pelvis, covering the site of the first anastomosis and obscuring the ureter. The sigmoid above was quite free and normal. The rectum was
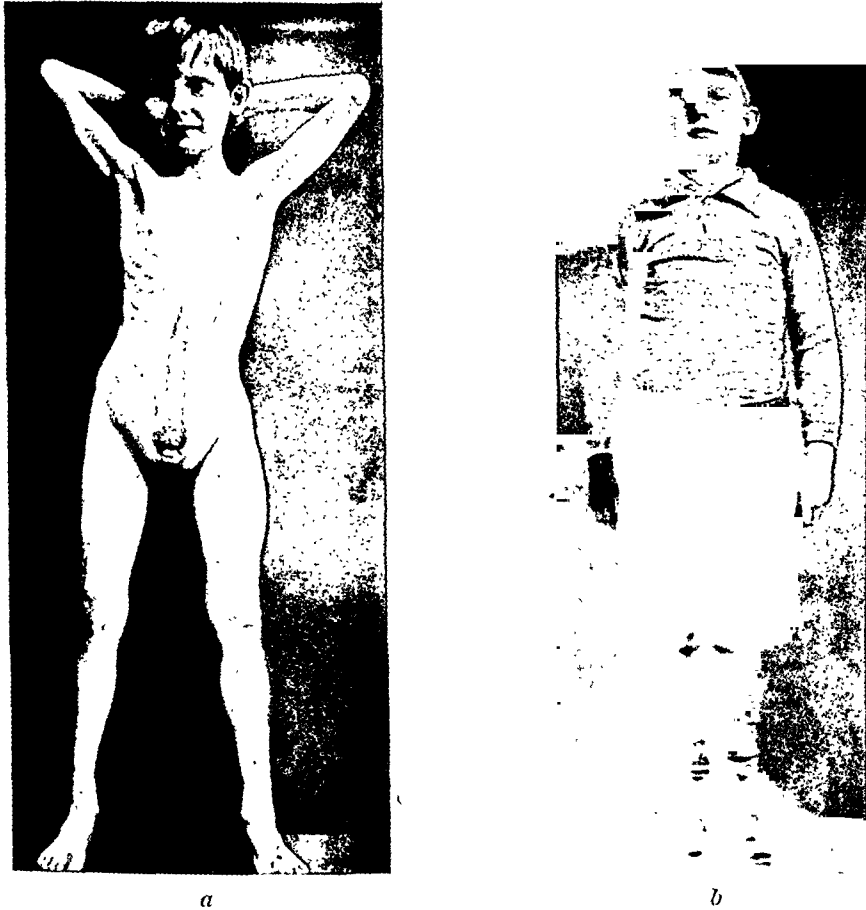
FIG. 100.—*Case* 12. J. P. Shows general development and nutrition
(*a*) before and (*b*) after operation.

much dilated, almost filling the true pelvis, and when later it was incised it was found to contain a good deal of liquid fæces. The right ureter was implanted into the bowel at a higher level by the same method, and the site of the anastomosis was fixed to the pelvic wall. The appendix, which was unusually long, was removed. Again a drainage tube was brought from the site of the anastomosis. The parietes were carefully sutured, and a large catheter was introduced into the rectum through the anus, through which liquid fæces at once escaped. The boy stood the operation well, and made an entirely uninterrupted recovery without any symptoms to suggest infection of the right kidney. From the time of admission until the day before the second operation the temperature was persistently subnormal. The day after the second operation it rose to 100° and remained about the red line, or just above it, for a week. The boy left hospital on Nov. 15 in very good condition and with improving rectal tolerance.

On Feb. 14, 1925, the patient was seen again.   He was very well, but still looked thin and delicate.   His mother stated that the bowels were moved many times daily, that he sometimes wet the bed at night, but that the condition was steadily improving.   In May, 1926, he was seen once more, and appeared to be in very good health, though still rather thin.   Owing to some misunderstanding he had been refused admission to school, but as a result of negotiation with the Education Authority this was rectified and he was allowed to attend.   A year later the schoolmaster reported that he was doing well and that he was quite of average intelligence.   His condition in no way interfered with his attendance.

FIG. 101.—*Case* 12. J. P. Skiagram of pelvis. December, 1927. The distance between the pubes is $2\frac{11}{16}$ in., and between the ischial spines $2\frac{7}{16}$ in. This boy has a distinctive gait, but plays games with his fellows and does not complain of weakness.

On Dec. 12, 1927, the boy came up for inspection.   He had greatly improved in every way, and looked plump and well.   He weighed 3 st. $12\frac{1}{2}$ lb. and was 4 ft. $4\frac{3}{4}$ in. in height (*Fig.* 100 *b*).   His mother stated that he had never ailed since he went home, and especially there have been no feverish attacks.   He takes food well, is happy and cheerful, and goes to school regularly, playing games just like other boys.   He walks characteristically with his feet a little apart, but there is no waddle.   X rays show a well-

FIG. 102.—*Case* 12. J. P.   The appearance of one of the ureteric orifices as seen by the sigmoidoscope : on the left at rest, on the right puckered and crenated during vermiculation and delivery of urine into the bowel.

developed pelvis, the pubes being separated to the extent of $2\frac{11}{16}$ in. (*Fig.* 101).   The evacuation of the rectum still occurs rather frequently, and he wets the bed a little at nights.   There is always a big stain, but the bed clothing is never soaked.   He empties the bowel at 8.30 a.m., 10.30, 12 noon, 1.15, 4, 5.30, and just before going to bed about 8 p.m., and gets up three or four times each night.   But there is a good deal of variation, and some days he does not go at 10.30 and 4, and only gets up once during the night.   In this

respect he is invariably worse in cold weather. The evacuation is always liquid, and usually fæces and urine mixed; it is very slimy and has a horrible odour. The boy states that he can pass flatus without any accident, and the mother says that his trousers are never soiled.

On the morning that he came to the hospital to report he emptied the rectum at 9.15, and at 11.40 he was requested to do so in order to suppy a sample. There was no desire, and when he tried he found he was unable to oblige, but about ten minutes later he voided a couple of ounces of fæces and urine mixed. On another day soon afterwards he passed at about 10.30 some 3 oz. of liquid fæces, at about 11.30 about 1 oz. of fæces and urine, and at 12.30 some 7½ oz., mostly urine. The anus showed no excoriation whatever, and the sphincter grasped the finger firmly. With the sigmoidoscope one ureteric orifice was seen at a distance of about six inches from the anus. It was like a papilla or nipple, rounded, smooth, and of a pink colour. Every now and again a wave of peristalsis passed over it, and just before urine escaped from its extremity it became shrunken and crinkled, the edges of the terminal orifice appearing bright red like a cherry (*Fig.* 102).

Summary.—Case of ectopia vesicæ in a boy, with total incontinence. Operation at 10 years of age. Transplantation of both ureters into recto-sigmoid at an interval of three weeks. Good recovery and improving health ever since. In December, 1927, he was 13 years and 4 months old, and in better health than ever before. Weighed 3 st. 12½ lb. and was 4 ft. 4¾ in. in height. Has perfect rectal continence during waking hours, but is sometimes wet at night.

Case 13.—**Ectopia vesicæ. Transplantation of both ureters in two stages at two weeks interval. Two years later plastic on bladder. Septicæmia. Death.**

W. B., male, age 4 years. (Reg. Nos. 16984–5.)

This patient was a small, weedy boy with complete ectopia (*Fig.* 103). The parents were most anxious to have him put right, and pressed for an early operation. There was complete ectopia, with wide separation of the pubes.

FIRST OPERATION, Sept. 28, 1925.—General anæsthesia. Mid-line incision. Much trouble from tendency of small bowel to escape from incision. Right ureter easily found and implanted into sigmoid. It was slightly dilated and thickened. Self-retaining catheter in rectum. Drain from near anastomosis removed in a week. Rectal tube came out at the same time. Boy made a very good recovery.

SECOND OPERATION, Oct. 12, 1925.—Median incision reopened. Many adhesions of omentum and small intestine to parietes. The rectum was found very dilated—catheter passed into anus and much liquid fæces evacuated. The left ureter was two or three times the normal size, and very thick-walled, but it vermiculated naturally. It was divided and its lower end ligatured. A rubber catheter, size 8, was easily passed into the upper end, but it seemed too big, so a No. 6 was substituted, and fixed by an encircling ligature of catgut. No urine escaped either then or up to the time of completion of the anastomosis. This catheter was passed into the rectum and out of the anus and buried in the wall of the sigmoid with the ureter. This was not so satisfactory as in cases where the catheter was not used, and before completion the catheter was withdrawn until only its extremity ;remained in the ureter. At the end of the operation no urine was escaping from the catheter, and none could be sucked out with a syringe. The catheter was therefore removed, but a big tube was left in the rectum. The operation took an hour, and the boy was cyanosed throughout. He was chesty for a day or two, but this cleared up. The rectal catheter came out the day after operation, and afterwards the bed was

FIG. 103.—*Case* 13. W. B., at the age of 4, just previous to the ureter implantation.

continuously wet. He did not ask for the bed-pan. There was no renal attack, and the boy took food well. The abdominal drain was removed on the tenth day, and there was no leakage of urine from it. The patient went home three weeks after the operation. Just before leaving there were signs of rectal control developing, but the bed was still continuously wet. The mother was given instructions about the necessity of training the boy.

In February, 1926, the patient was quite well and continence was developing. In November he was still very well and was growing, but was extremely thin. The Education Authorities wanted him to go to school, and he began soon afterwards.

In August, 1927, the boy was very well in every way. He was attending school regularly and playing games just like other boys. He weighed 3 st. 2 lb., but looked very thin. The parents were advised to allow him to return to have the mucous membrane of the exposed bladder removed, and he was re-admitted for this purpose on Dec. 8, 1927. He still looked small and delicate and was very thin, weighing only 2 st. 12 lb. 3 oz. and being 3 ft. 11 in. in height. He was bright, cheerful, and intelligent, and took ordinary food very well. Both testicles were descended and normally developed. While lying in hospital rectal control was fairly good during the day for one to two and a half hours, but there was a good deal of incontinence at night. X rays showed separation of pubes to the extent of $2\frac{1}{8}$ in. Examination on Dec. 13 of two separate samples of urine passed per rectum resulted as follows: First sample: Amount, 550 c.c.; reaction, strongly alkaline; albumin, present; blood, present (pyramidon); urea, 1·31 per cent. Second sample: Amount, 250 c.c.; reaction, strongly alkaline; albumin, present; blood, trace; urea, 1·62 per cent.

It was intended to carry out the operation on Dec. 13, and the boy was taken to the theatre for that purpose and anæsthetized. Dr. Markham, the anæsthetist, remarked that he was rather a feeble subject, but nevertheless the boy struggled vigorously while going under the anæsthetic, which was A.C.E. followed by open ether. Altogether the administration lasted for thirty-five minutes. The rectum was first examined. The anus grasped the finger, but not vigorously, and it at once became patulous after the introduction of the sigmoidoscope. On introducing the latter about 2 oz. of urine escaped from the lower rectum, and it seemed remarkable that this did not escape during the administration of the anæsthetic. When the instrument was advanced further into the bowel, beyond the rectal shelf, several further ounces of urine gushed out, making a total collected of $6\frac{1}{4}$ oz., a good deal being lost. The latter came away almost clear, but with a lot of mucus, and following it a considerable amount of liquid fæces escaped. A careful and systematic search did not discover the ureters, and there was nothing to suggest where they might be hidden. Indigo-carmine, 1 c.c., was given by intramuscular injection, but there was no indication of blue discoloration in the bowel, and at the end of twenty minutes from its administration the search was discontinued. As this examination was rather prolonged it was not thought wise to proceed with the removal of the bladder, and the boy left the table at the end of thirty-five minutes in good condition. He very quickly recovered from this examination, and did not appear at all upset, certainly not more than is usual in ordinary children. Four days later the plastic operation on the bladder was carried out.

THIRD OPERATION, Dec. 17, 1927.—General anæsthesia was again employed, and he was under its influence for about forty minutes. The greater part of the vertical scar and the bladder were encircled by an incision and excised in one piece. The removal of the bladder opened up the cellular tissue of the pelvis, and left a deep hole leading to the recesses of the pelvic cellular tissue, as indicated in the drawing (*Fig.* 104). Several rather large vessels required ligature. The recti were widely separated, certainly to the extent of $1\frac{1}{2}$ in. Their sheaths were opened and the muscles drawn together in the upper part, but this could not be completed towards the pubes as the tension was much too great. The deeper sutures were supported by flaps cut from the rectus sheath and turned over, by these steps the cavity left after removal of the bladder was diminished and partly covered, but it could not be completely obliterated. A tube was therefore brought from the depths, and the remainder was packed with iodoform gauze. The skin came quite well together except at the lowest part. This operation appeared to be well borne.

PROGRESS.—On the day following operation there was nothing to cause anxiety, but on Dec. 19 the boy looked very ill. There was frequent vomiting, and he was tender in the left flank. The pulse was very quick and of poor tension. Saline infusions with digitalin and strychnine were used. The next day he appeared to be a little better. The kidney regions were fomented and the boy took a good deal to drink. By night he was worse; there was more vomiting, he looked very ill, and was restless. On Dec. 21 he was still very ill and the vomit was black. Until the previous night the bed had been soaked, but not since, suggesting suppression of urine. He was given water per rectum by the gravity method, and the nurse was astonished at the amount which entered the bowel and was retained. Unfortunately it was not measured, but it was much more than usual in a child, and certainly over two pints (a child of this age cannot be expected to retain more than about 10 oz.). There was no elevation of temperature, and the condition was looked upon as entirely due to renal insufficiency, and it was decided to expose the kidneys with a view to drainage, or decapsulation, or both, as indicated. About noon on Wednesday, that is, the fourth day after the operation, with local anæsthesia and a little gas and oxygen, this was carried out. Both kidneys were large and firm and there was no surrounding œdema. They were not unhealthy to the naked eye and the pelves were not dilated. In both the capsule was completely stripped, and this was done without any difficulty. The incisions were packed with gauze and left open, boric foments being applied. It struck the operator that by this method the kidneys could be directly fomented, or the patient
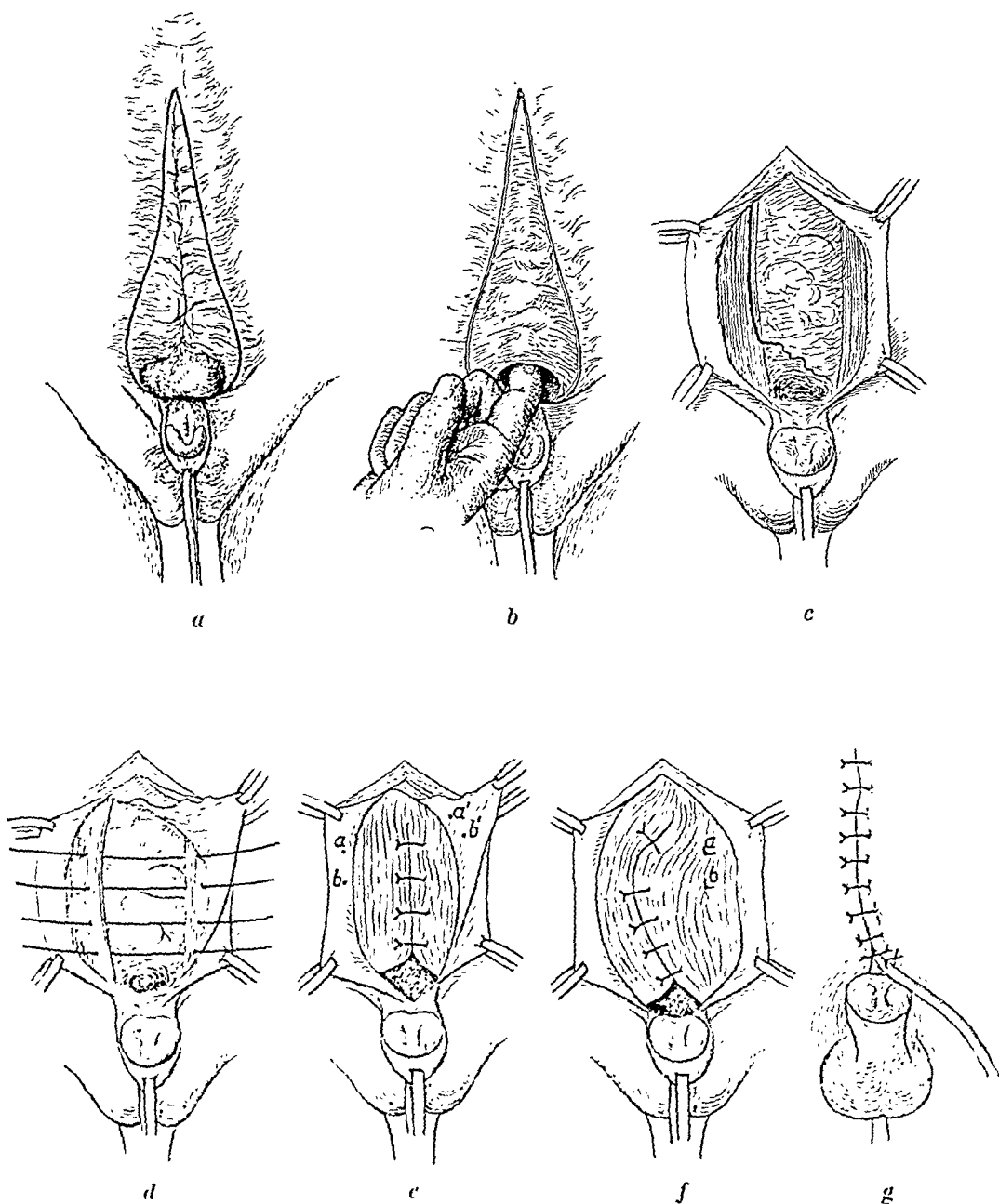
FIG. 104.—Case 13.   A series of line drawings showing the steps of the plastic operation carried out.   The lower part of the scar and the exposed bladder were first excised.   In the next two diagrams the recti and much-stretched linea alba are shown. The recti are then shown drawn together, and finally the turned-up sheaths were overlapped and fixed by suture, the points *a*, *b*, to *a'*, *b'*.   The drainage tube shown in the last diagram was brought from the depths of the pelvic cellular tissue.

could be put in a bath and the kidneys kept directly in contact with fluid of any temperature. This operation took about twenty minutes and the boy did not appear to be upset by the interference. Unfortunately there was no improvement and he died at 7 p.m.

POST-MORTEM EXAMINATION.—The body was emaciated, and there was some decomposition about the median incision. The colon could not be distended per rectum—i.e., fluid would not run in, and simply regurgitated through the flaccid sphincter. There was no peritonitis. The whole pelvis was filled with contorted, dilated, and adherent sigmoid, rectum, etc., so that nothing else could be seen. The kidneys, ureters, and whole colon and rectum, with the anus, were removed intact. On separating the left ureter some pus was noticed in the retroperitoneal tissue near its lower end. This seemed to have travelled upwards, either from the neighbourhood of the ureteric anastomosis on that side, or from the extraperitoneal cavity from which the bladder had been removed. The liver was slightly enlarged, soft, and very fatty, owing to recent acute change. There was some purulent pleurisy on both sides and a very little pleural fluid; no bronchopneumonia, only a little congestion the result of general septic invasion. The heart and pericardium were not affected.

The parts removed were subsequently carefully examined. The colon was filled with formalin from the ileum after suture of the anus. It was noticed that the fluid did not distend the ureters, and could not be made to do so even by manipulating the bowel, ureters, etc. The latter were filled by using a hypodermic syringe passed into the kidney pelvis on each side. When the fluid was subsequently removed from the colon it was carefully measured and found to be 1110 c.c.; some of the formalin had already escaped, and the bowel was not greatly distended, i.e., not tightly blown up. The condition of the parts as seen from behind is well shown in Fig. 105.

The rectum above the pelvic diaphragm was much thicker than below, and was pathologically hypertrophied.

The right kidney (Fig. 106) (the one which was anastomosed first) was slightly enlarged, measuring $3\frac{1}{2} \times 2$ in. It showed definite hydronephrosis involving all the calices. The cortex was generally diminished and the surface was scarred in several places, and opposite the scars the cortex was narrowest. The dilated pelvis was thickened, reddened, and contained muco-pus, and was very hyperæmic towards the calices.

The right ureter was dilated to about four times the normal size. In the prepared specimen the widest part was half an inch across. As it approached the right side of the bowel it was much narrowed in comparison, but actually about normal, or only a very little bigger. Exactly $1\frac{3}{4}$ in. of the ureter was buried in the bowel wall. The track of the

FIG. 105.—Case 13. W. B. This patient died 2 years and 3 months after the implantation of the ureters. The drawing shows the parts removed after death as seen from behind.
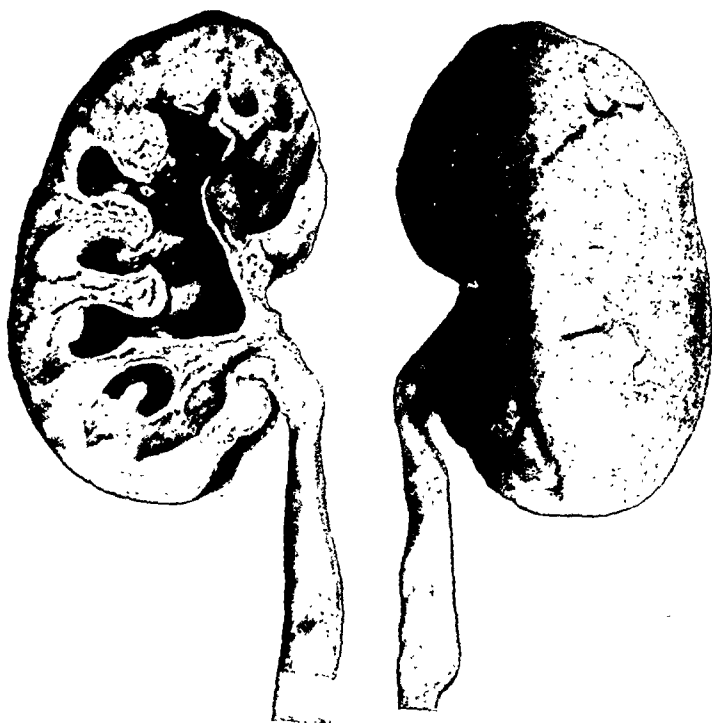
FIG. 106.—*Case* 13. W. B. Right kidney.

FIG. 107.—*Case* 13. W. B. Left kidney.

buried ureter could be seen from inside the bowel, which was raised up over it. The passage was oblique and gradual. The opening into the bowel appeared as a small depression, obscured by a mucous fold. In the specimen it was to the right and posterior. The part of the bowel into which the ureter opened was just above the pelvic diaphragm. The diameter of the opening was about $\frac{1}{15}$ in. or smaller. At first it appeared slit-like, but was dilated during the examination. This opening was quite hidden, and was only demonstrated after passing a probe down the ureter from above (see Fig. 120).

The left kidney (Fig. 107) was slightly smaller than the right. The pelvis was scarcely, or very little, dilated, and not in the least hyperæmic. The kidney substance looked healthy, but the cortex in the lower half was considerably diminished. The surface was scarred, but to a lesser extent than the right. (In both cases the capsule stripped very readily during life.) The microscopic appearances are shown in Fig. 108.
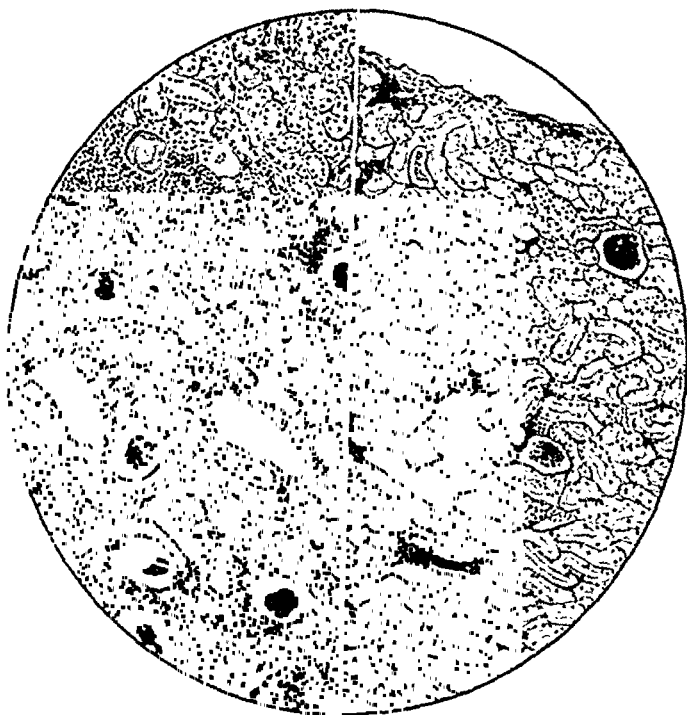
FIG. 108.—Case 13. W. B. Microscopic appearances of (a) right and (b) left kidneys. (× 60.)

The left ureter was about half the size of the right; it opened into the bowel to the left side of the bowel, and behind and at this point was considerably narrowed. The opening into the bowel, as seen from the lumen of the latter, was like a circular rosette raised at least ¼ in. from the surface of the mucous membrane. It was a little more than that in diameter, roughened on the surface, and like a wart or closely packed polypus (see Fig. 120). It opened into the bowel opposite the internal iliac artery, above the pelvic diaphragm. Two inches of this ureter were buried in the bowel wall.

By measurement it was found that the right ureter opened into the bowel 3½ in. from the anus, whereas the left was 8 in. from that point—i.e., their orifices in the bowel were 5 in. apart, and were separated by a complete bend of the bowel, closely and firmly fixed by adhesions.

The rectum, below the pelvic diaphragm, was ballooned and thin-walled, with what looked like normal mucous membrane. The bowel (? upper rectum, lower sigmoid) above the pelvic diaphragm was very definitely dilated, thicker in its wall, and with reddened mucous membrane, in contrast with that in the bowel in the compartment above into which the left ureter opened. The remainder of the colon looked normal from the outside, though it was much larger than would be expected in a child of the same age. It measured 26 in. from the ileocæcal valve to the commencement of the sigmoid. The latter was so coiled and adherent that the length of it and the rectum could not be ascertained.

Case 14.—**Ectopia vesicæ and double inguinal hernia. Transplantation of one ureter by the method of Peters. Septic dermatitis and cancrum oris. Death.**

J. M., female, age 1 year 4 months. (Reg. No. 17407.)

HISTORY.—This child was the youngest of a family of five ; she had been brought up on Glaxo. The parents were in very poor circumstances, and were more distressed about the encumbrance of the child than its welfare. It was quite obvious that they could not, or would not, be bothered with the child in its abnormal condition. Until the age of 7
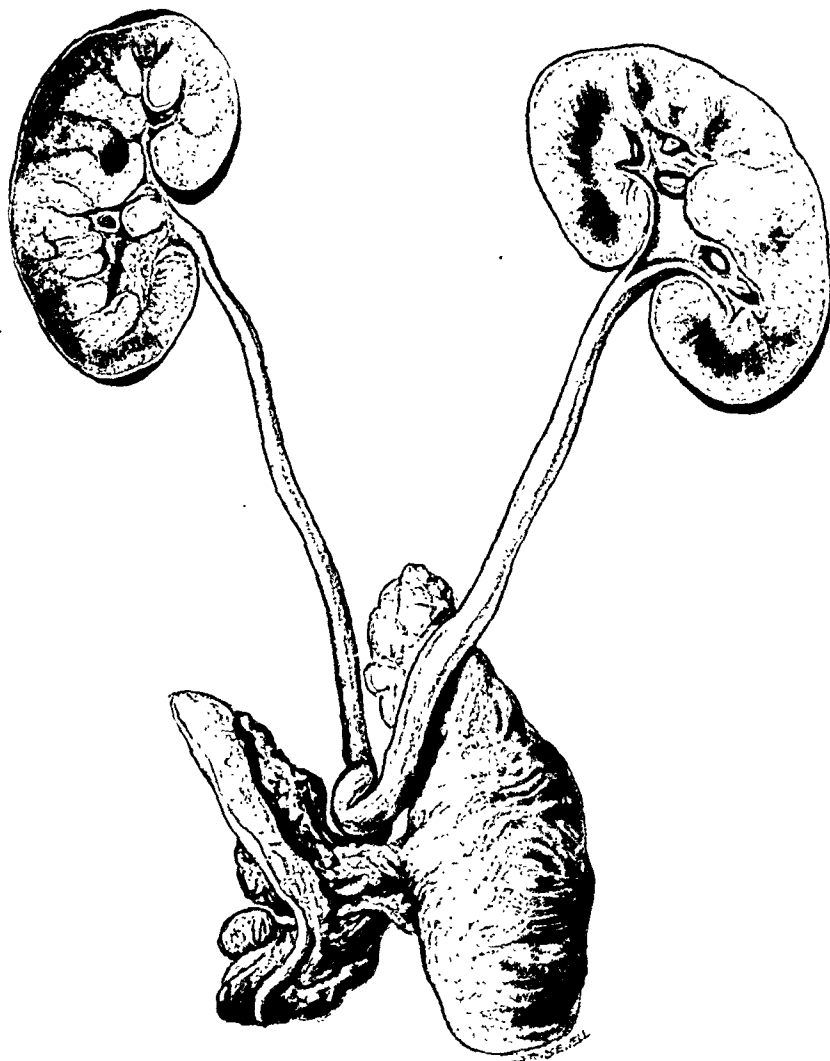
FIG. 109.—*Case* 14. J. M. Child of 1 year and 4 months. Left ureter implanted into rectum by Lendon-Peters method. Death at end of a week. The ureter had slipped out of the rectum and was lying in an abscess cavity. The corresponding kidney showed evidence of dilatation and ascending infection.

months this child did well, but it then began to suffer from prolapse of the rectum, probably the result of neglect. When seen the child was ill-nourished, peevish, and constantly crying. There was moderate prolapse of the rectum, but with a fairly good rectal sphincter. In this condition Dr. Dunlop Lickley kindly admitted the patient under his care at the Children's Hospital. The child was carefully fed and nursed, and was given seventeen doses of ultra-violet light, and had boric baths twice daily. Under this régime she steadily

improved, and in six months had gained 2 lb. 6 oz. She occasionally suffered from screaming fits, apparently associated with the descent of double inguinal herniæ. The rectal prolapse occurred only once, and that during the first week the child was in hospital. After five months' treatment the baby was transferred to the Newcastle Infirmary in very good condition.

OPERATION, May 28, 1926.—General anæsthesia. The left ureter was implanted into the rectum by the Peters method, no fixation sutures being employed. The patient stood the operation well. On May 30 the child was not well. It looked pale and ill. The temperature was 102·6°, and there was a small (?) anæsthetic burn on the chin. The latter spread rapidly, and a generalized rash appeared on the body. The condition was diagnosed as measles, and the child was sent to Isolation. The temperature remained high, 103° to 104°, and the child was very ill. The supposed burn on the face rapidly presented a condition like cancrum oris. The wound in the base of the bladder became very septic, and death took place just a week after the operation.

POST-MORTEM EXAMINATION.—General septic dermatitis, with large patch on the right cheek like cancrum oris. There was a small abscess behind the extroverted bladder, between it and the rectum on the same side as the ureter transplantation. The right ureter and kidney were normal, but the left ureter was dilated and thin-walled, and the corresponding kidney was about half as large again as the right, and was very soft and friable. The capsule stripped readily and on section the substance showed a condition of pyelonephritis. The pelvis and calices were dilated and contained some purulent urine, and there were several abscesses in the medulla.

Microscopically, this kidney showed a well-marked ascending simple infection along the tubules which had scarcely reached the cortex of the organ. The right kidney showed a well-marked parenchymatous degeneration, but no evidence of a true nephritis or of ascending infection.

The rectum and lower ends of the ureters were removed in one piece. When subsequently examined the left (transplanted) ureter was found to have slipped out of the rectum and was lying behind the bladder in the area in which the above-mentioned abscess was found (*Fig.* 109).

Case 15.—This is described as a continuation of *Case* 9.

T. L., male, age 8 years 8 months.   (Reg. No. 17328.)

Case 16.—Total epispadias with incontinence.   Transplantation of ureters in two stages at three weeks' interval.   Acute pyelonephritis.   Recovery.

J. H., male, age 3 years.   (Reg. No. 18140.)

HISTORY.—The patient was a fine, healthy boy, weighing 2 st. 9½ oz., and 36½ in. in height. The urethra was open on its dorsal aspect throughout its whole length, and communicated with the bladder by an orifice which easily admitted a finger (*Fig.* 110). X rays demonstrated separation of the pubes to the extent of one inch (*Fig.* 111). When lying on the back a certain amount of urine collected in the bladder before it overflowed, but it all escaped involuntarily when the boy stood up. A No. 14 self-retaining catheter in the bladder enabled practically all the urine to be caught, and there was only a very little leakage round the tube. While in hospital awaiting operation he took his food well, and appeared to be in every way normal. An X-ray picture of the forearm and femur, made for subsequent comparison, showed well-formed, normal bones.

FIRST OPERATION, Oct. 1, 1927.—General open ether anæsthesia. Trendelenburg posture. Median incision from just above the umbilicus to just above the bladder opening. This was a trifle over 4 in. long, and, with the aid of the self-retaining retractor, gave quite a good exposure. At first the parts looked alarmingly small but this did not give rise to any real difficulty. The left ureter was selected for the first anastomosis; it was normal in size and easily identified. After incising the peritoneum over it, the ureter could be lifted from its bed and did not require any special separation. Its vessels were seen intact and were not interfered with. After dividing the ureter a spot was selected on the sigmoid convenient for the anastomosis—that is, where the necessary manipulations could be comfortably carried out. This point was a finger's length from the bottom of the pouch of Douglas, which proved by measurement to be 3 in. No clamp was used on the bowel, and the ureter was implanted by the method of Stiles, except that it was made to lie obliquely in the bowel, and not along the longitudinal band. One and a half inches of the ureter were buried. The bowel at the point where the ureter entered was fixed to the edge of the pelvic peritoneum. A small tube was brought from the region of the union and through the mid-line incision. The parietal wound was closed by figure-of-eight silk-worm sutures. The operation occupied one hour and ten minutes. A catheter was left in the rectum at the conclusion of the operation, and from this, during three succeeding periods of twenty-four hours, 8 oz., 7 oz., and 12 oz. of urine were collected.

PROGRESS.—On Oct. 4 the boy appeared to be quite well, but without warning commenced to vomit and did so copiously for some hours. He soon got over this, but it may have been a kidney reaction. He certainly got thinner for a day or two and was quieter,

FIG. 110.—*Case* 16. J. H., boy, age 3. The testicles were descended. The pubes were separated to the extent of one inch.

FIG. 111.—*Case* 16. J. H. Skiagram of pelvis.

but he gradually picked up and by the 21st he appeared to be in about the same condition as before the operation.

SECOND OPERATION, Oct. 22.—The right ureter was implanted into the bowel; general anæsthesia and technique as before. The abdominal incision was 2 in. longer. The

sigmoid was adherent to the back of the parietes. The ureter was very small, and was purposely divided obliquely. A small tube was again brought from the region of the anastomosis. This time also the operation occupied one hour and ten minutes. At the end of the operation 1 oz. of liquid contents was evacuated from the rectum. A large catheter was stitched into the rectum as before.

PROGRESS.—The child stood the operation very well, but the condition was never quite satisfactory afterwards. He vomited almost continuously, a vomit which made his lips and face sore. Nothing stayed down; thirst was inordinate, and he drank cold water copiously and continuously. By the 24th his condition gave rise to great anxiety; the vomiting continued; he looked pinched and thin; the ears were a little cyanosed; and his pulse was very quick (130–140) and of low tension. The abdomen was neither distended nor rigid. After a restless night the condition on the morning of the 25th appeared desperate, and it was decided to explore the right kidney.

THIRD OPERATION, Oct. 25.—A minimum of general open ether anæsthesia. The right kidney was easily exposed by an oblique muscle-cutting incision. There was no extraperitoneal œdema, no obvious signs of gross mischief. The kidney was a little larger than normal, but the pelvis was not dilated. The latter was opened and its mucous membrane found to be intensely engorged, but there was no escape of urine. The capsule was stripped from the kidney and the wound packed with gauze and left almost entirely open.

PROGRESS.—The condition appeared to improve at once. In the afternoon, as he was restless and had not slept since the operation on the 22nd, a dose of $\frac{1}{16}$ gr. of morphia was given. At 10.30 p.m. he was found restful, of better colour, and with a pulse of good volume. He had not vomited since 3.30. The next day, the 26th, the boy looked much better. There was a little vomiting and the abdomen was a little distended. The catheter was removed from the rectum. Large foments were applied to the right flank and abdomen. Calomel and pituitrin were given, and in the evening there was some slight action of the bowels. During the day he slept a good deal and was altogether more restful. Afterwards he steadily improved and only vomited once or twice. On the eighth day following the exposure of the kidney, there was some escape of urine from the incision for the first time. By the end of November he was greatly improved. The mid-line incision had gaped a little and healed by granulation. Now both incisions were soundly healed. The boy was taking food again and looking well. He weighed 1 st. 11 lb. 2 oz. So far as could be ascertained there was no sign of rectal control; when he left hospital a few days later, he was wrapt in a napkin like a baby, and this was frequently wet and had to be changed. By the end of the year the mother reported that the child had been very ill since going home but was now much better: was able to be up; was walking; and had permission from the doctor to go outside. "Has nearly got control of his bowels."

REPORT ON URINE.—The urine in this case, both before and after operation, was carefully examined under the supervision of Dr. J. C. Spence, whose report follows:—

Sept. 27–28 (before Operation), Urine Collected at Intervals from a Catheter in the Bladder for Twenty-four Hours—

	Amount	Specific Gravity	Urea
2.30 p.m. to 4.30 p.m.	78 c.c.	1019	1·19 per cent
4.30 p.m. „ 8.0 p.m.	46 c.c.	1015	1·81 „ „
8.0 p.m. „ 2.0 a.m.	105 c.c.	1022	2·31 „ „
2.0 a.m. „ 5.30 a.m.	105 c.c.	1014	1·62 „ „
5.30 a.m. „ 8.0 a.m.	170 c.c.	1006	1·35 „ „
8.0 a.m. „ 2.30 p.m.	180 c.c.	1015	1·31 „ „

Trace of albumin; numerous red blood cells; some pus cells.

Sept. 28, Urea Concentration Test (10 grm. urea).—

	Amount	Specific Gravity	Urea
1st hour	140 c.c.	1112	1·87 per cent
2nd hour	65 c.c.	1013	3·12 „ „
3rd hour	70 c.c.	1016	3·81 „ „

The chief points in these results are: (1) High concentration of urine urea (3·81) after urea; and (2) No fixation of specific gravity (varying from 1006 to 1022 in twenty-four hours). These are to be regarded as evidence of good renal function.

Blood-urea.—It was found impossible to get blood for estimation on the 27th or 28th. Blood was obtained only at the first operation on Oct. 1, when the patient was under an anæsthetic; this was 78 mgrm. per 100 c.c.—higher than normal, but probably accounted for in part by the anæsthesia.

Nov. 25, after both Ureters were Transplanted.—Urine collected from the rectum contained 1·94 per cent urea. Blood-urea, 39 mgrm. per 100 c.c.

Nov. 29.—Blood-urea, 40 mgrm. per 100 c.c. The blood-urea estimations of Nov. 25 and 29 are slightly raised, and to be taken as evidence of slight impairment of renal function.

Report.—The progress of the renal function of this case should be followed by repeated blood-urea estimations. A steady rise from the present level of 39–40 mgrm. per 100 c.c. would denote progressive deterioration.

Case 17.—Ectopia vesicæ. Transplantation of one ureter.

G. M., female, age 3 years 8 months. (Reg. No. 18139.)

HISTORY.—This patient was the third child of strong, healthy, sensible parents, the other children being normal in every way. The child was fair-haired, anæmic, and delicate-looking. In addition to the ectopia the whole bladder area was herniated and the linea alba was very wide (*Figs.* 112, 113). Weight 1 st. 9 lb. 10 oz., height 33 in. The shape of the head and slight thickening about the epiphyses suggested rickets. The patient was under observation for a week and during this time took food well and appeared normal in every way. Urine was collected by ureter catheter from both kidneys. Analysis by Dr. Spence gave the following results (Dec. 13, 1927): Specimen from left ureter: Reaction, acid;
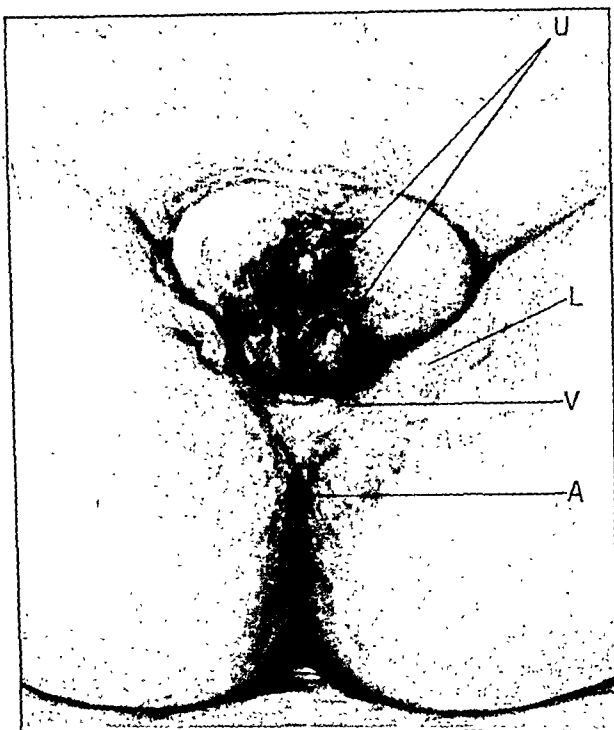
FIG. 112.—*Case* 17. G. M., a little girl 3 years and 8 months old. The parts before operation. The pubes were widely separated, but the connecting ligament was so strong that the child could be lifted from the table by a finger in the rectum. Note the excoriation of the labia and buttocks.
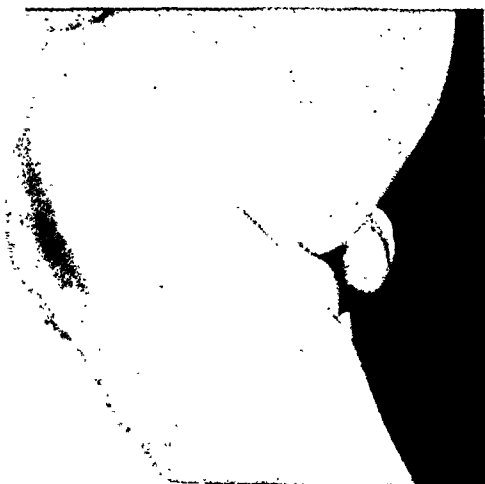
FIG. 113.—*Case* 17. G. M. To show the hernia of the bladder in profile.

albumin, present; urea, 1·5 per cent. Specimen from right ureter: Reaction, acid; albumin, present; urea, 0·5 per cent. Mr. John Brumwell also catheterized the ureters and made pyelograms of both kidneys. This examination showed both ureters were dilated, the right more than the left (*Fig.* 114).

OPERATION, Dec. 17, 1927.—Combined spinal (stovaine ½ gr., strychnine $\frac{1}{150}$ gr.) and general ether anæsthesia. The Trendelenburg posture was adopted ten minutes after administration of the spinal anæsthesia. In a few minutes respiration became very slow and sighing, and caused some anxiety. At first the abdomen was quite flaccid, and there was no tendency for the bowel to escape, but as the effects of the spinal anæsthesia wore off, prolapse of the intestine occurred, and was troublesome. This difficulty was exaggerated because the embarrassed

respiration following the spinal anæsthesia deterred the anæsthetist from using more ether. The right ureter was dilated to about four times the normal size, but the left was only half as big. The right vermiculated very vigorously on stroking. It was implanted into the sigmoid by the method of Coffey. The union seemed secure, but the method was not considered as satisfactory as the Stiles plan. The operation was more difficult than usual because of the general smallness of the parts, the fact that the ureter was almost at right angles to the bowel, and because of some anxiety about the anæsthetic. The whole proceeding occupied one hour and fifteen minutes, and the child was returned to bed in very good condition.

PROGRESS.—Recovery was quite uneventful and without any definite evidence of kidney reaction. The incision healed rather slowly and gaped a little, but the granulations were quite healthy. The child went home at the end of three weeks, and was subsequently reported to be doing well.

This child was re-admitted in May, 1928, when the second ureter was transplanted by the Stiles method. Recovery was again quite uneventful, and the patient continues to make good progress (January, 1929).

FIG. 114.—Case 17. G. M. Pyelogram made by Mr. John Brumwell. The dilatation of the right ureter (on the right side of the figure) was confirmed at operation.

I am very much obliged to many doctor friends who have taken so much trouble to keep me informed of the after-progress of these cases.

THE BEST AGE FOR THE OPERATION.

This depends a good deal on the size, development. and general health of the child. The earliest age at which I have personally operated by the intraperitoneal method is 3 years. At that age the parts are small and the pelvis is difficult of access, and unless for some very special reason I do not propose to operate again so early. In my view the age of election is between 5 and 7, depending on the considerations already mentioned.

EXACT TECHNIQUE OF METHOD EMPLOYED.

In some of the patients potassium citrate has been administered for a week before operating, but otherwise no special preparation has been used.

I propose to describe the operation as I have carried it out, leaving suggested modifications, etc., to be dealt with in the section devoted to ALTERNATIVE METHODS (p. 173).

There are some few anatomical peculiarities which need to be emphasized. In cases of complete ectopia the surgeon must realize that the umbilicus is merged in the apex of the ectopic bladder, and that there is always separation

of the pubes, which may be of very considerable degree—in this series from 1 in. to as much as 3½ in. The linea alba is correspondingly wider than normal, and is represented by a strong, fibrous structure which, at its lowest part, merges with a fibrous ring surrounding the upper circumference of the ectopic bladder. In a good many of these cases the ureters are dilated, and in one of my youngest patients (*Case* 17) this was demonstrated by the method of pyelography (*see Fig.* 114), which was carried out for me by Mr. John Brumwell. Possibly the dilatation may develop subsequently in some of the cases, but it is often present as an associated part of the deformity.

The ureter is well supplied with blood-vessels, and many of them run for a considerable distance in the loose cellular tissue which forms a sort of sheath in which it lies. It is essential that as far as possible these vessels should be spared, and when the ureter is lifted from its bed, if they are not deliberately divided, they may often be preserved if the surgeon uses the method of blunt dissection or gauze stripping. In *Fig.* 89 such a vessel is seen lifted from its bed with the ureter, but remaining unharmed at the completion of the operation.

The difficulty of ensuring an aseptic field in the presence of the exposed mucous membrane is evidently more theoretical than practical, for, with the doubtful exception of *Case* 11, there has been no serious infection attributable to this source.

In most of my cases general anæsthesia, induced by A.C.E. and followed by open ether, has been employed. In younger subjects the tendency of the intestines to escape has caused embarrassment, and to avoid this it has been suggested that the patient should be put in the Trendelenburg posture before the administration of the anæsthetic. I have tried combined spinal and general anæsthesia, and it has been helpful from this point of view, but it is an anxiety in the young child, and especially where the Trendelenburg posture is employed. After all, temporary evisceration ensures the best view of the pelvis, and is not serious provided that due care is exercised in covering the exposed bowel and keeping it warm and moist.

In cases of ectopia the exposed bladder is first packed with iodoform gauze. I have always employed a vertical incision from the umbilicus where it exists, and otherwise from its position down to, but not through, the ring of dense fibrous tissue which surrounds the upper border of the exposed bladder. Once the peritoneum is opened, the intestines are packed away in the upper abdomen so as thoroughly to expose the pelvis with the sigmoid and upper rectum.

The right ureter is now always selected for the first anastomosis, because it can be most conveniently implanted into the lowest part of the selected bowel. In all cases I have easily identified the ureters, which have invariably been found lying in their normal position crossing the iliac artery. The only doubt will arise when the ureter is much dilated, but such doubt will always be set at rest by the vermicular movements of the ureter, which occur naturally at regular intervals, and which can be set up by stroking over its course with a closed artery clip, or by gently pinching the tissues in the neighbourhood with forceps.

The sigmoid is drawn up and to the left, and the site for the anastomosis is marked by a catch forceps introduced into the anterior longitudinal band. The first ureter is joined to the bowel at the lowest point which can be conveniently reached for suturing, and this in children will probably be a finger's length, say $2\frac{1}{2}$ to 3 in., from the bottom of the rectovesical pouch. In the more roomy pelvis of adults this point may be still nearer to the bottom of the pouch.

The ureter is now exposed by picking up the peritoneum which lies over it, and by incising this structure for a distance of two or three inches, depending again on whether the subject is a small child or an adult. The ureter is laid hold of with fine, mouse-tooth forceps and gently lifted from its bed of cellular tissue near the bladder; it is caught with an artery forceps as low down as possible, and divided across above the forceps. I have not found any forceps which will conveniently catch and hold the ureter sufficiently firmly to prevent slipping and at the same time without crushing, so that I now leave the lumen of the upper end unguarded, and merely take a small hold of one side of its wall with a catch forceps. The upper end of the ureter, which is to be used for the implantation, is then separated from the cellular bed in which it lies. This is easily accomplished by the aid of a dissecting forceps, or a small piece of gauze held in a clip used as in the method of gauze stripping. Only a little more of the ureter is separated than is going to be buried in the bowel wall, so that probably 2 in., or at most $2\frac{1}{2}$ in., will suffice, of course depending on the size of the subject. The large amount of ureter shown separated from its surrounding cellular tissue and elevated from its bed, in articles which have recently appeared in the medical press, is very misleading. The greatest care is taken not to divide or tear the small blood-vessels which are found passing into the ureter, for they will usually strip up and stretch sufficiently. The upper end of the ureter is thus first separated so that by turning it upwards its lumen is kinked and an escape of urine is avoided even in the absence of an occluding clip, but as an extra precaution its open end is laid in a mop of gauze. The exposed mouth of the lower end of the ureter is then carbolized, ligatured with catgut (No. 3/0 chromic), and allowed to retract into the cellular tissue towards the bladder.

A small $\frac{3}{8}$-in. incision is now made through the longitudinal band on the large bowel in the transverse direction and just above the point already marked by the catch forceps. This incision cuts through the muscular coat and exposes the mucous membrane, which is pulled up into the incision and incised just sufficiently to allow the ureter to be introduced into the lumen of the bowel without being constricted.

The upper end of the divided ureter is then trimmed obliquely, and a catgut suture (3/0 chromic gut) is passed through its pen-nib end and tied. One end of this suture is cut so as to be left 3 in. long, and this portion is coaxed with a probe into the open mouth of the ureter, so that it occupies the lumen of that portion of the tube which has been lifted from its bed. This is the catgut urine guide of Charles Mayo. These steps are illustrated in Figs. 115 and 116. The long end of the suture is then threaded on a curved needle, which is passed into the lumen of the bowel and brought out half an inch lower down. By means of this thread the ureter is drawn

into the lumen of the sigmoid; by tightening the stitch it is made to lie close up against the mucous membrane of the bowel, and is there fixed by tying the suture on the peritoneal aspect of the bowel. Usually the hole into the lumen of the sigmoid is a little too large to accommodate the ureter, and is diminished by one or two interrupted sutures so that it lies snugly round the latter.
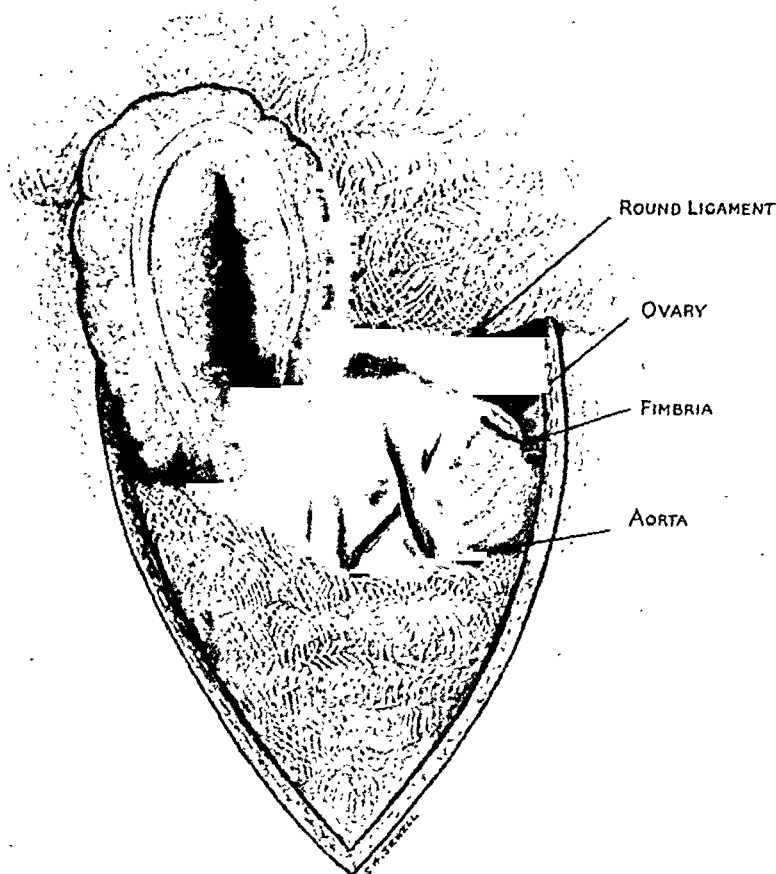
FIG. 115.—*Case* 17. G. M. The pelvic contents with ureters as exposed in the first stage of the operation. Note the dilatation of the right ureter, which was previously demonstrated by pyelography. For the sake of clearness the posterior parietal peritoneum is not shown.

The process of burying the ureter is now carried out by a series of four interrupted sutures (3/0 chromic gut) which take a good hold of the bowel on either side, but at such a distance that when drawn over the ureter the latter has ample room to lie in the groove so made without fear of causing its constriction. The amount of bowel wall required for this purpose will, of course, depend on the size of the ureter in each individual case. The first of these inverting sutures commences just above the fixation stitch, and

they are inserted $\frac{3}{8}$ in. apart. The second and third stitches just catch the outer wall of the ureter. The ureter is buried obliquely in the bowel wall so that when the anastomosis is completed it passes comfortably direct from the opening in the posterior peritoneum to the intestine without kinking. A second and final row of six sutures buries the fixation stitch and the first row of inverting sutures. Two additional sutures are passed through the outer wall of the bowel near the point where the ureter
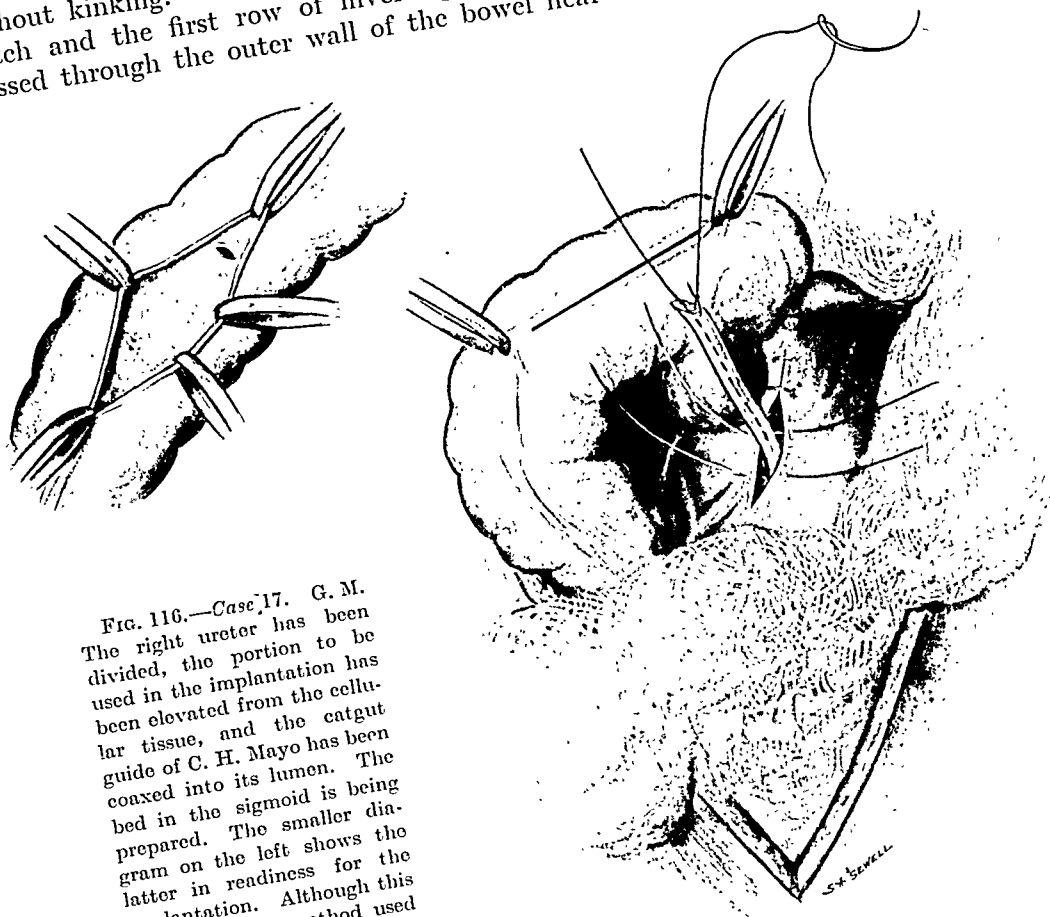
FIG. 116.—Case 17. G. M. The right ureter has been divided, the portion to be used in the implantation has been elevated from the cellular tissue, and the catgut guide of C. H. Mayo has been coaxed into its lumen. The bed in the sigmoid is being prepared. The smaller diagram on the left shows the latter in readiness for the implantation. Although this was the actual method used in Case 17, the oblique implantation shown in Fig. 89 has usually been used and is preferred.

enters, and are used to fix the bowel at this point to the edges of the peritoneal slit, as shown in Fig. 89.

When the anastomosis is completed the ureter should not be visible, for it should pass directly from its bed behind the peritoneum into the channel in the bowel. A fine rubber tube, about $\frac{1}{8}$ in. in diameter, is brought from the neighbourhood of the anastomosis either out through the lowest part of the median incision, or up behind the peritoneum to an independent opening in one or other iliac fossa, the most direct route being followed. After removing the gauze from the pelvis especial care is taken to protect the small

bowel by covering it with the omentum, and the parietal incision is closed. Whenever possible the peritoneum is sutured by a continuous stitch, but the main support for the wound is a series of figure-of-eight silkworm sutures one inch apart, and tied over rubber tubes. A few intermediate catgut stitches in the aponeurosis are valuable. Great care must be taken to close the extreme lower end of the incision, for this tends to gape, and in one case (*Case* 3) a piece of small intestine escaped and became strangulated, necessitating operative interference for its return.

At the conclusion of the operation a large rubber catheter (size 14) of the self-retaining type is left in the rectum in the hope of preventing an accumulation of urine, or urine and fæces. If it does not slip out spontaneously it is removed on the fourth day. In the cases where the bladder is exposed, the dressing of the incision must be kept separate from the dressing over the bladder; but in actual practice there has been no untoward incident due to the soiling of the incision from this cause. In examples of complete epispadias it is usually possible to introduce a self-retaining catheter into the bladder, and to draw off the urine in this way until the second ureter can be dealt with.

The operation in my hands has occupied from forty minutes to an hour, depending for the most part on the size of the pelvis. There has been very little shock, even in the youngest children. Urine commences to escape from the rectum within an hour or two, and at first, and for some few days, flows almost continuously. The bowels act without help, but sometimes a dose of calomel or castor oil has been administered if indicated.

The mild attacks of kidney infection which may come on during the immediate convalescence are usually ushered in with some pain in the affected side. On the other hand, sudden collapse or a rigor may mark the onset. The temperature soon runs up to 102° or 103°, and the pulse is correspondingly quick. The next day there is tenderness in the loin, and soon after the enlarged and tender organ may be felt. In three or four days the symptoms have usually subsided. It is surprising how little the patients seem to be upset by these attacks.

After-treatment.—No special form of after-treatment has been adopted, the patients being treated as after any ordinary laparotomy. It might help to ward off attacks of mild renal infection, and might hasten the process of stabilization, to give plain water by the bowel, and in future I am disposed to give this plan a trial.

Implantation of the Second Ureter.—This is deferred until the patient has completely recovered from the first interference. As a rule, a fortnight or three weeks suffices for this purpose. At the second operation I have always re-opened the original incision. The omentum is usually adherent to the abdominal wall, but there are only a few flimsy adhesions in the pelvis, and I have never found these obscuring the parts to
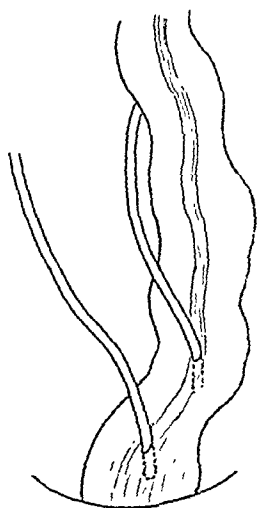
Fig. 117. — Showing the proper disposition of the transplanted ureters in relation to the bowel.

an inconvenient degree. The site of the first anastomosis is usually quite hidden, and I think it is unwise to attempt to expose it.

The second ureter is usually the left, and it is exposed as it passes over the pelvic brim, and is joined to the bowel on the inner side of the recto-sigmoid, the disposition of the two ureters being as indicated in *Fig.* 117. The details of this second stage are precisely the same as for the first operation.

REPAIR OF THE LOCAL DEFORMITY.

The repair of the local deformity is not such an easy problem as it appears. The excision of the mucous membrane of the bladder may be attended with very considerable hæmorrhage, and, even with the greatest care, in one of my cases (*Case* 3—a young adult of 19) the blood loss was enough to affect the patient very considerably. It is probably easier to excise the whole thickness of the bladder wall, but after this has been accomplished a large hole is left between the recti muscles leading into the pelvic cellular tissue, and from the depths there may be an amount of oozing which can only be controlled by the introduction of gauze packing. It sounds reasonable to talk of drawing the recti together, and covering the sutured muscles with the undercut skin from either side, but as a matter of fact the wide separation of the pubes, which is universal in cases of ectopia, renders this very difficult (*see Fig.* 104). In the one female case in which I have repaired the vulval region after excision of the bladder mucous membrane, I had very considerable difficulty in securing approximation because of the tension of the soft parts. Even after reasonable apposition had been obtained, the amount of tension was sufficient to cause some of the stitches to cut out. It is not even easy to be sure that the whole of the mucous membrane of the bladder has been removed, and in cases where this has apparently been carried out successfully, an island has sometimes remained which continues to be red and moist.

C. J. Bond[6] considers that the mucous membrane of the exposed bladder changes its character and comes to resemble the ordinary skin of the abdominal wall, and that therefore it is unnecessary to interfere for its surgical removal. On the other hand, Charles Mayo[7] and others have drawn attention to cases in which epithelioma has developed on the exposed mucous membrane, and they have used this as an argument in favour of its removal. In my experience I have seen neither of these developments, but I think that, on general grounds, it adds to the comfort of the patient if the external, and obvious, deformity is repaired as far as possible. In some cases in which the ectopia falls short of completeness, it may be possible, even in the male, so far to close the anterior aspect of the bladder and the urethra as to make the patient appear more or less normal. In these lesser degrees of deformity the problem is not so difficult, as there is not such wide separation of the pubes. In complete epispadias the gap between the bladder and the dorsal surface of the urethra can be readily covered in and the parts restored wonderfully satisfactorily. In *Case* 8 (*Fig.* 96), by such intervention the copulative and procreative faculties appear as if they would be abundantly restored.

Among the many alternative methods suggested for dealing with ectopia, I still remain attracted by the plan suggested by Trendelenburg of dividing the sacro-iliac joints with the idea of securing approximation of the pubic bones so that the bladder may be pushed back into position and be secured by suture of its anterior margins. This manœuvre might be helpful after successful transplantation of the ureters, as one of the steps towards the more complete repair of the deformity associated with the ectopia itself.

OPERATIVE MORTALITY AND COMPLICATIONS.

In this series of 17 cases it will be seen that there have been 4 deaths directly due to the operation, a mortality of 23·5 per cent. Since most of the cases have been dealt with in two stages there have been 28 separate operations, making the mortality 14·3 per cent. It we take the number of times the separate ureters have been transplanted, we have 29, with 4 deaths, equal to a mortality of 13·8 per cent. The Mayos, in a series of 60 cases, had a mortality of 13·33 per cent.

In my own series the cause of death in three of the cases was peritonitis. In the first patient (*Case* 4) this resulted from sloughing of the ureter, with pelvic peritonitis. There was also an acute ascending pyelonephritis. In that case both ureters were transplanted at one sitting. In the next death (*Case* 6) the peritonitis was due to a direct leak from the second ureter. The latter was much dilated and the last fixation stitch had entered its lumen. The third death (*Case* 11) was also the result of peritonitis, following the first ureter transplant. In this case the anastomosis was intact, and the pathologist was inclined to think that the infection had arisen in the neighbourhood of the abdominal incision.

The fourth death occurred in *Case* 14, a baby of 1 year and 4 months. One ureter only was transplanted, by the Lendon-Peters method, and the child died of a general septic dermatitis with cancrum oris. Post mortem an abscess was disclosed behind the bladder, and the end of the ureter was found to have escaped from the rectum. This retraction of the ureter had evidently occurred some time after the anastomosis, because the ureter was found dilated and the kidney enlarged and infected.

Most operators have noticed that the fatalities have occurred either when both ureters have been transplanted at one sitting, or after the transplantation of the second ureter in the divided operation. In a case operated upon by a colleague, which he very kindly allows me to mention, the child of 4 died on the tenth day following the anastomosis of the second ureter. During the days which elapsed after the operation the child vomited continuously and rapidly wasted. At the post-mortem a septic peritonitis was found, most marked in the pelvis, where there was much purulent fluid and lymph. The ureter last transplanted was markedly dilated as far as the pelvic brim, at which point it had sloughed and given way. The part of the ureter between the pelvic brim and the bladder was much thickened, and intensely black on its mucous surface (*Fig.* 118). The corresponding kidney was enlarged, and showed gross evidences of infection spreading into the substance from its distended and infected pelvis. Recovery after transplantation of the first ureter to be dealt

with in this case had been without incident.   At the post-mortem the anasto-
mosis looked sound and the kidney was apparently unaffected.   A more
critical examination showed that this ureter was completely obstructed in its
passage through the bowel, and it is questionable whether the anastomosis
had ever functioned.   Quite probably the absence of the customary reaction
on that side had failed to protect the opposite kidney from the severe inflam-
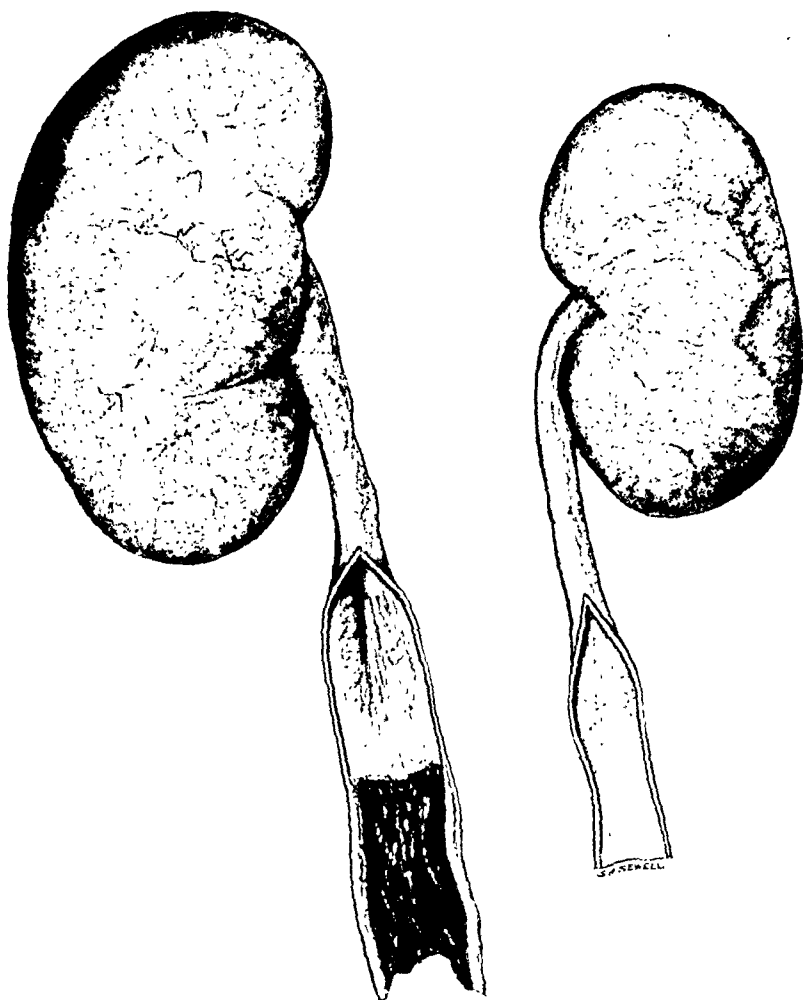
FIG. 118.—Gangrene of the ureter as found post mortem 7 days after transplanta-
tion into the bowel.   The corresponding kidney is enlarged and was infected.

matory troubles which followed the second operation.   It is in guarding
against a sequence of this sort that the catgut urine guide of Charles Mayo
is so valuable.
     The reiteration of the causes of death in my cases goes to show the
wisdom of the prophylactic operative measures which have now been incor-
porated in the routine operation—namely, the two-stage operation, the catgut
urine guide, and the drain tube from the site of anastomosis.

GENERAL HEALTH OF THE RECOVERED CASES.

A perusal of the case records will show that the general health of the ten surviving patients is not far removed from normal, as judged by ordinary standards rather than clinical laboratory tests.

It takes time for the system to become accustomed to the altered state, and it is a question of months or even as long as two years before the condition of the patient can be said to have become stabilized. In the intervening period they are acquiring complete rectal toleration and the kidneys are presumably accommodating themselves to the element of constant mild infection. It may also be that there is continuous absorption of urine from the bowel,

50. oʒo.   *l. oʒ.*   *44.oʒo.*
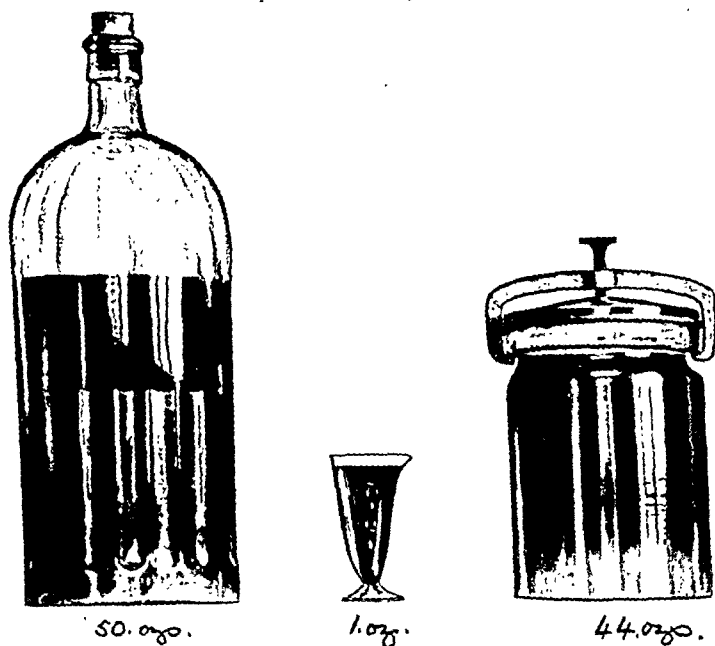
Fig. 119.—Case 9, T. H., a boy age 4 years, after implantation of the ureters into the bowel. To represent graphically the horrible discomfort and distress that must attend total incontinence of urine. The Winchester quart contains the normal daily secretion, and the 44 oz. in the specimen jar is the amount passed per rectum in this case after successful transplantation of both ureters.

and this may have some effect on the general nutrition and well-being. Whatever the cause, the records of the cases show that the condition in the first two years is not so satisfactory as afterwards. This is important from a practical point of view, and I think that during this period it is wiser not to attempt any such operative interference as may be desirable for the removal of the bladder mucous membrane or other plastic procedures. Fortunately during this period of stabilization the patients are not ill in the sense of being laid up, and in fact the new-found blessing of continence (*Fig.* 119) buoys them up so much that they can afford not to be depressed about any little physical weakness that may be present. They sleep and eat well and are ordinarily

active, but they keep thin, or even get thinner, and may be anæmic and seedy. When stabilization is complete they fill out, gain colour, and increase in strength and happiness. The change is often very striking, and has usually been a matter for remark by their friends. Eventually they get so well that they are able to do just as others of their age. Thus children attend school and enjoy games with their playmates, while older patients are able to work and to assume the responsibilities and duties befitting their station.

Judged by the standard of weight and its relationship to height and age, many of the patients are below normal; but the fact must not be overlooked that in almost every case, before the operation they were smaller and less developed than children of their own age. This particularly applies to *Cases* 1, 7, 12, 13, and 17, who could only be looked upon as delicate children, and unsuited for any but the most necessary operation.

TABLE SHOWING RELATION OF AGE, WEIGHT, AND HEIGHT
(CORRECTED FOR SEX).

| | | URETER TRANSPLANTS | | | | NORMAL | | |
Case	Age	Height		Weight		Height		Weight	
		ft.	in.	st.	lb.	ft.	in.	st	lb.
2	36	5	1½	7	2	5	1	8	9
3	29	5	10	10	7	5	7¾	10	12
1	24	5	4½	7	9	5	7¾	10	8
8*	19	5	4½	8	9	5	7¼	9	13½
5	16	5	0	8	9	5	1¾	8	1
7	14	4	2¾	4	2¾	4	11¼	6	8
12	13	4	4¾	3	12½	4	9	5	12½

* Only one ureter transplanted.

The original development of the children seems to have more to do with the ultimate result, so far as general health and strength is concerned, than anything associated with the actual operation. For instance, *Case 3*, who was not operated upon until he had attained the age of 19 years, was a big, strong lad at that time. Convalescence was interrupted by intestinal obstruction, and he was submitted to a plastic operation during the early weeks following the transplants, yet he has developed still further and is able to carry out the ordinary duties of a farm worker. *Case 5* was very ill after the second transplant, either as the result of some sloughing of the ureter or perinephritis, but in spite of this she has grown big and strong, and is more robust than any of the other patients. *Case 10* did very well and enjoyed really excellent health until overtaken by an attack of intestinal obstruction, and yet at the post-mortem one of the kidneys showed gross dilatation and evidence of infection. The case of T. L., *Case 9* and *15*, is also illustrative, for he has apparently only one functionally active kidney, and that with a greatly distended ureter and liable to attacks of infection, and yet his general health and development appear to be little affected. *Case 2*, who married

since the operation, has become the proud mother of two healthy children, and is now, thirteen years later, wonderfully well and leading a life of great activity.

RECTAL TOLERATION.

Rectal toleration does not develop at once, but the time required for the lower bowel to become accustomed, not only to the presence of urine, but to the unwonted amount of fluid contents, is very variable. As might be expected, the younger the subject, the less the control at first, yet all but the youngest patients have learnt to ask for the bed-pan before the time of leaving hospital. After the second stage of the operation toleration at night comes remarkably quickly and, except in the early stages, 'wet beds' are uncommon. Immediately after the operations, and for the first day or two, the urine seems to run away constantly from the anus, so much so that I often do not think it necessary to persist in keeping a catheter in the bowel, for the presence of such a foreign body in the anus is greatly resented.

When once toleration has been acquired it is very wonderful, for most of the patients can hold urine for several hours during the day, and nearly all night, without any discomfort. In the cases in which this could be ascertained, the average time was 3 hours. The longest was $4\frac{1}{2}$ hours. All the patients state that though they have the desire to evacuate the rectum three or four times each day, they can contain the urine a good deal longer if circumstances demand it. Most of the patients get up once by night, and sometimes twice or even thrice. As a rule they waken without trouble, but *Case* 3, who has always had some incontinence by night, states that he empties the rectum quite involuntarily during sleep, and is not conscious that he has done so. On the other hand, *Case* 12 passes urine three or four times every night, but sometimes when very tired he does not get up to use the chamber, and a wet bed results.

The quality of the urine seems to have more to do with the toleration of the rectum than the quantity. When patients are suffering from 'renal attacks' and have presumably highly infected urine, they have great frequency, or even incontinence, though at ordinary times these same patients may have perfect toleration. When the patients are quite well the capacity of the bowel may be tremendous. For instance, on one occasion *Case* 1 held his urine as long as possible—i.e., from 9 a.m. to 1.15 p.m.—and then evacuated no less than 29 oz., which looks a formidable quantity in a Winchester quart! At one o'clock this boy had a meal, and just before he commenced to eat he said he felt anxious to empty the bowel; but the desire soon passed off, and he was able to wait in comfort until he had finished eating. Another patient (*Case* 3) held his urine as long as possible, and then voided 18 oz. The general health, quite apart from the question of renal infection, seems to have something to do with this question of toleration.

RECTAL FUNCTION AND CONTROL.

Usual amount voided at a time	.. ..	5 oz.
Amount which can be comfortably retained	..	10 oz.
Maximum amount passed at any one time	..	29 oz.

Out of 10 cases, 7 have perfect control both day and night, and 3 have some incontinence at night only.

The problem of where the urine is actually stored in the bowel is of great interest. It cannot be in the rectum, for this part of the bowel is quite unable anatomically to contain the quantity of fluid which sometimes collects. In some of the cases submitted to sigmoidoscope examination, interesting information has been obtained on this point. On passing the instrument just within the sphincter, a small amount of urine escapes—2 to 3 oz.; but on advancing the instrument to examine the upper rectum, or lower sigmoid, a further and much larger quantity comes away; and as the higher reaches of the bowel are explored, still further amounts are evacuated. Post-mortem specimens showing enlargement and distension of the colon suggest that the whole of the large bowel may act as the reservoir. In *Case* 13, who was operated upon for the repair of the local defect two years and three months after the transplantation, the nurse who administered water per rectum was alarmed at the amount which easily flowed into the bowel by gravity. Unfortunately no accurate measurement was made, as the importance and interest of the point were not then realized, but she did observe that there was well over two pints. This boy unfortunately died, and his rectum and whole colon were filled, though not distended, with formalin solution in the preparation of the specimen, and for this purpose 1120 c.c. (39½ oz.) of the fluid were used. In *Case* 10, who also died, these observations were not made, but the colon was certainly more than usually capacious.

I have no facts to prove whether or not the fluid contents of the colon in these cases is absorbed, as has been assumed, but that is a matter which merits inquiry.

The anal sphincter, as tested by the finger, I have always found to be competent and alert, and that was so even in the case of a boy (*Case* 9) who was alleged to have loss of control, and who certainly had some slight anal prolapse at times. That the sphincter is more than usually active is proved by the fact that when these patients are placed under full anæsthesia the anus does not allow any escape of the rectal contents, and yet the passage of a catheter or the sigmoidoscope into the rectum demonstrates the presence of an ounce or two of fluid contents. When the latter instrument is used under anæsthesia and is passed a few times, the anus may become patulous; but in the absence of anæsthesia it remains on guard, and, from the story of the patients, without any effort so far as they are concerned.

Four of the patients state that they can pass flatus independently of evacuation, but nearly all the others expressed their inability to do so.

Sigmoidoscopic examination has been carried out both with and without anæsthesia. No special preparation has been used, and in every case, except for liquid contents, the bowel has been found empty of fæces and quite clean and healthy-looking. The mucous membrane is invariably moist and looks oily, but is otherwise normal. It does not seem to be unduly sensitive, and is capable of considerable air distension. The gradual filling of the instrument with liquid, and the constant steaming of the eyepiece by the warm urine, are new and interesting experiences. The search for the orifices of the ureters has not always been successful. Eight sigmoidoscopic examinations were made in seven patients, and one or both ureters were found in only four. In one patient (*Case* 5) both ureters were seen on one occasion soon after she had

recovered from an attack of renal infection, and the corresponding ureteric orifice was found pouting and bright red in colour. On another occasion, two or three years later, a painstaking examination entirely failed to discover either orifice!

In the post-mortem specimens which are available, two types of ureteric opening are demonstrated (*Fig. 120*). In the one the opening is funnel-shaped and is hidden beneath a fold of mucous membrane. In this type the area
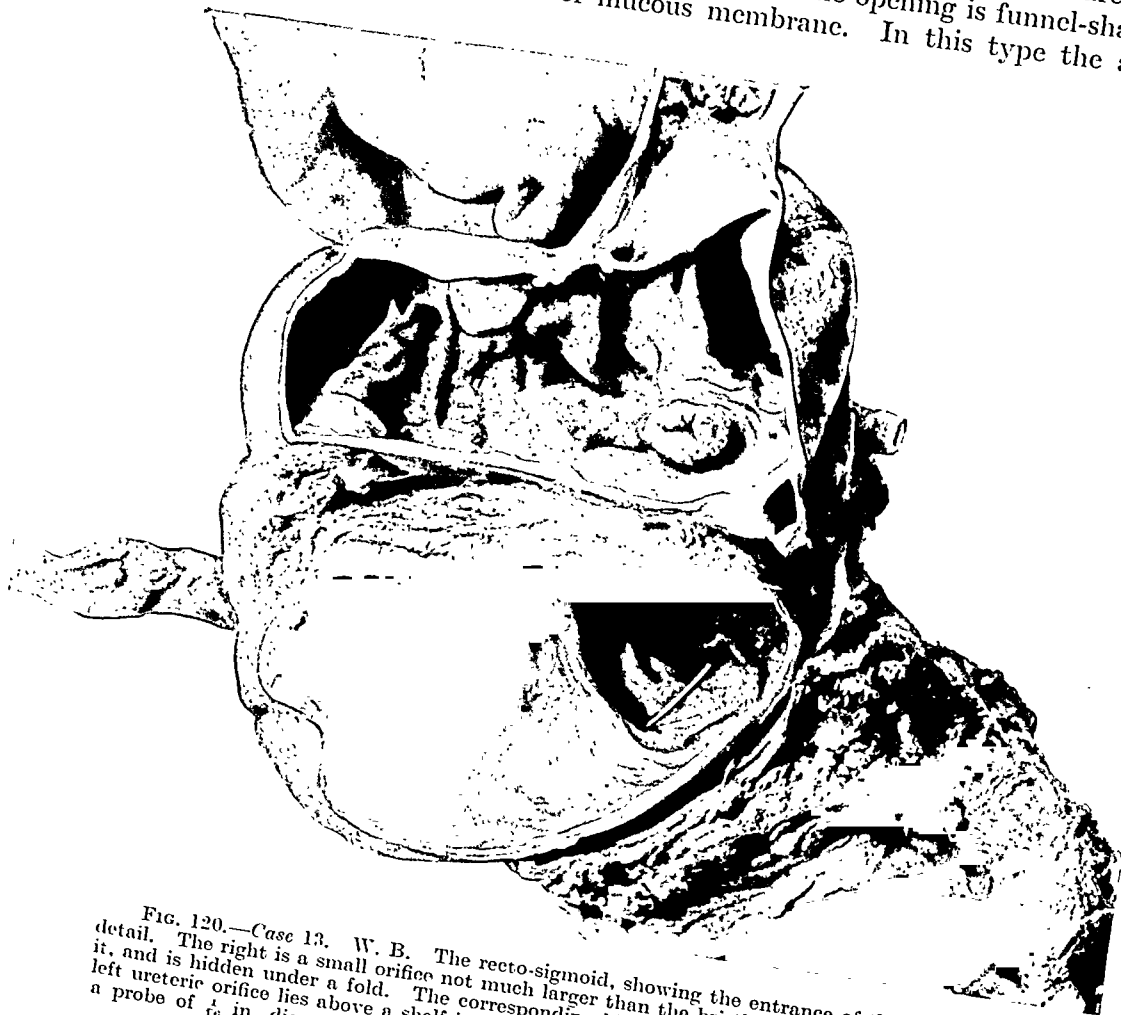
FIG. 120.—*Case 13*. W. B. The recto-sigmoid, showing the entrance of the ureters in detail. The right is a small orifice not much larger than the bristle which is thrust through it, and is hidden under a fold. The corresponding kidney was dilated (*see Fig. 106*). The left ureteric orifice lies above a shelf in the bowel, and is like a rosette. It easily admitted a probe of $\frac{1}{16}$ in. diameter.

from which urine has trickled or suffused has been seen, but there is no definite spurt to indicate the actual orifice. The other type, represented by a sort of rosette, can be clearly seen and functions characteristically. As seen in the coloured drawings (*Figs. 92 and 102*), carefully made by Mr. Sewell from his own observation, these openings are on the summit of what looks like a polypus (*Case 12*), or more a cow's udder or the uvula (*Case 3*). When quiescent these excrescences hang flaccid, and are of a colour slightly pinker

than the surrounding mucous membrane ; but when about to discharge urine they are seen to vermiculate. and then to retract, the extremity becomes irregular and pouts. and urine is discharged in a small spurt.   In *Case* 3 the urine came from the side of such a uvula-like process. near its base, and not from the extremity.   The discharge of urine appeared to be at about the normal rate and quantity, but I am not sure that this is necessarily an evidence of a normal ureter.   In *Case* 9 the ureter. which had previously been implanted into the rectum by the Lendon-Peters method, was subsequently exposed on the floor of the ectopic bladder as the result of accidental injury during a plastic operation, and was seen to eject *clear* urine in spurts, but. on introducing a ureteral catheter. a quantity of *pus* was evacuated.   At a subsequent operation. when this ureter was implanted into the bowel, it was found to be dilated almost to the size of the small intestine.   So far as an isolated observation goes, this suggests that a dilated ureter may vermiculate and evacuate its contents at the normal rate.   The intramuscular injection of indigo-carmine has not helped in the identification of ureteric orifices otherwise elusive.   In *Case* 3, in which the ureteric uvula was first found. the blue effluent appeared at the normal time—seven minutes—and identified the site of the orifice very beautifully (*see Fig.* 92).   The orifices which have been seen have usually been found just at the point at which the internal iliac artery causes a prominence in the bowel, and by measurement this was found to be about 8 in. from the anus.

The character of the evacuations is interesting.   As a rule fæces and urine are intimately mixed. making up an offensive puddle with an indescribable odour.   At other times the patient may void a soft, pultaceous stool, and sometimes, though rarely, a solid evacuation.   At still other times the same patients will get rid of clear urine which has a decidedly offensive odour and contains an excess of mucus.   On one occasion (*Case* 12) the patient, in the course of a three-hour morning. passed first 3 oz. of thick, pultaceous fæces, then 1 oz. of quite liquid mixed fæces and urine, and lastly $7\frac{1}{2}$ oz. of turbid urine which deposited about 25 per cent of fæcal matter.   Some of the patients always pass mixed fæces and urine. while others habitually void clear urine at one time and the mixed fæcal puddle at another.

None of the patients have complained of untoward irritation of the rectum, and the sigmoidoscope has not demonstrated the presence of proctitis, though this was found in a mild degree at the post-mortem in the two patients (*Cases* 10 and 13) who were confined to bed for some days before death. Possibly the excess of mucus which is always present exercises a protective action on the bowel wall.   The rectum from *Case* 10. the boy who died from intestinal obstruction 3 years and 3 months after the ureter transplant, does show some thickening of all the coats, and the mucous membrane is covered with an inflammatory exudate (*see Fig.* 97).   It must be remembered that this patient was very ill and confined to bed for a week before the specimen was taken.

At one time the patient W. K. (*Case* 3) was so much troubled with nocturnal incontinence that he always slept in a puddle.   During this period the skin round the anus was sodden and whitened, resembling the skin of the abdominal wall around a suprapubic urinary opening.

WIDENING OF THE PELVIS.

Widening of the whole pelvis which results from the separation of the pubes is quite a striking feature which must not be overlooked (*see Figs*. 101 and 111).

A good many of these patients walk with a tendency to waddle, suggesting the gait of patients suffering from congenital dislocation of the hip. In one or two of the patients this has caused anxiety to the parents, but I have not known any complaints from the patients themselves, and they certainly appear to get sufficiently strong to enable them to carry out practically anything, just as normal children or individuals, and certainly this condition seems to be less noticeable and to give rise to less trouble as they grow older.

THE RENAL FUNCTION.

Judged by the standard of the general health, it may be said that none of the patients in this series shows definite evidence of gross renal insufficiency.

At the outset I must say I feel convinced that most of these patients develop some degree of ascending renal infection. This is borne out by the fact that in the two cases in which it has been possible to make post-mortem investigations there has been definite and gross evidence of its existence, in spite of the fact that during life neither of these patients suffered from symptoms indicating its presence.

Among the ten cases that are alive and well, and on which I have definite information on this point, there are three patients (*Cases* 8, 12, and 17) who, at 7 years, 3 years and 3 months, and 8 months after operation, have never suffered from any symptoms indicating renal infection. In *Case* 8 only one ureter has been transplanted.

Cases 1 and 2 have suffered from slight attacks of pain in one or other kidney region, with lassitude, possibly temperature, and frequent micturition, but these symptoms have never caused serious inconvenience.

Case 3 has suffered three or four times from a very definite kidney infection, and in one attack he was very ill with a high temperature (105°) and a tender left kidney.

Case 5 is the patient who, during her immediate convalescence, developed a perinephric abscess on the right side. In spite of this she has developed into a big, strong, robust girl, but she has on four or five occasions suffered from a recrudescence of infection, although in the intervals she has remained perfectly well. Since the Hunterian Lecture was delivered this girl has had another attack, and X rays show what is almost certainly a renal calculus on the right side.

Case 7, during immediate convalescence, suffered from intraperitoneal infection which probably originated about the site of the anastomosis, and though he has developed very well and is in very good health, he has at least twice suffered from febrile attacks of renal origin as shown by tenderness over the kidney regions.

Cases 9 and 15 refer to the same patient. This is the boy with one functional kidney with a greatly dilated ureter. After the intraperitoneal transplantation he had a smart attack of infection of the left kidney, and

three months later this was followed by a severe attack, ushered in by rigor and vomiting. His general health is good, and development is proceeding normally.

Case 10 was in remarkably good health until his death, which was due to peritonitis following an operation for intestinal obstruction. The peritonitis was the result of leaks in connection with an intestinal anastomosis. At the post-mortem examination both kidneys were found dilated, there was evidence of infection, and microscopically both interstitial and epithelial changes were found.

Case 12 probably suffered from some renal infection after the transplantation of the first ureter, but he made an entirely uninterrupted recovery after the second operation, and has exhibited no signs of renal infection since.

Case 13 was also particularly interesting, because he never showed clinical evidence of gross renal infection, but, on his death, which occurred two years and three months after transplantation, both kidneys showed marked evidence of ascending infection.

From these clinical observations it would appear that a moderate degree of renal infection is not inconsistent with average good health and well-being. It is to be remarked that, not only are these patients in good average health, but they stand up well to the trials of their ordinary environment. As the case records show, several of them successfully underwent operations under general anæsthesia without untoward symptoms. Further, Case 2 was not more than ordinarily upset by child-bearing and lactation. The fact that both the patients who died after operations subsequent to the transplantations (Cases 10 and 13) showed acute renal infection superadded to the gross and long-standing changes is not, in my opinion, any evidence that these patients were suffering in that way before their fatal illness. Mechanical drainage does much to minimize the effects of a chronic renal infection, and the fact that these patients were bedridden would in itself tend to allow the infection to run riot. Further, the acute exacerbation was probably more of the nature of a terminal outburst.

Chemical examination has only been carried out in a few cases, and the results, so far as they have been obtained, are set out in the following table :—

THE RENAL FUNCTION.

CASE	PERIOD SINCE OPERATION	PERCENTAGE OF UREA IN EVACUATION	BLOOD-UREA MGRM. PER 100 C.C.	AGE—WEIGHT—HEIGHT RATIO	GENERAL HEALTH
1	14 years	0·62	52	Below normal	Very good
2	13 ,,	1·5	27	,, ,,	,, ,,
3	10 ,,	1·5	34	Normal	,, ,,
5	5 ,,	0·6	—	Below normal	,, ,,
7	7 ,,	0·5	21	,, ,,	,, ,,
8*	6 ,,	0·5	36	,, ,,	,, ,,
9	4 ,,	1·3	—	,, ,,	Rather thin and weakly
12	3 ,,	0·37	—		
13	2 ,,	1·62			

* Only one ureter transplanted.

Most of the patients are abnormally thirsty and drink copiously of water, and they state that the quantity evacuated per rectum bears a definite ratio to the intake. In three cases the total amount passed per rectum has been measured. V. K. (*Case* 5) passed 33 oz. in twenty-four hours. This was three years after the operation had been completed, and she was then 9 years and 8 months old. *Case* 9, a boy of 4 years of age, passed 44 oz. in twenty-four hours (*see Fig.* 119), and *Case* 10, a boy 10½ years of age, seventeen days after operation, passed only 25 oz. in the twenty-four hours. It is quite likely that more urine is passed as the renal organs become more accustomed to their altered condition.

ALTERNATIVE METHODS.

In this series of cases, with two exceptions, I have adopted the plan of intraperitoneal implantation of the ureter, largely based on the technique of Sir Harold Stiles. The Peters operation, or rather the Lendon-Peters operation, appeals to one because of its simplicity, and I believe it might have been attended by more success if it had been the rule to transplant the ureters by this method in two stages. But it is a method in which the operator has no opportunity of controlling the exact site of the anastomosis, and it can only be carried out in males. There are several cases on record in which the ureter has slipped out of the bowel, and in which, in consequence, an obstruction has formed which has interfered either with the immediate success of the operation, or with the subsequent utility of the anastomosis. This accident occurred in one of my cases (*Case* 14), and *Fig.* 109 illustrates exactly what was found post mortem. There are methods by which such an accident might be prevented, and these have sometimes been adopted, such as fixing the ureter by a stitch to the rectal wall, or fixing it by means of a catheter inserted into its lumen. Personally I much prefer the intra-abdominal method, which is under the guidance of the eye and can be more directly controlled in all its details. Of course, when available, the Lendon-Peters method can be employed in very young children, and should it prove a failure for any reason the intraperitoneal method can still be carried out at a later stage if the patient survives.

The most important recent contribution to this subject has been made by Robert C. Coffey, of Portland, Oregon, U.S.A., who has devoted very considerable attention to the transplantation of the ureters, and I am much indebted to him for keeping me informed of the progress of his work. In a series of recent papers he has drawn attention to improvements in the methods which have hitherto been employed. He first devised the plan of making the implanted ureters lie for a considerable distance in a submucous bed (*Fig.* 121), in the hope that the ureter would be compressed and temporarily closed by the pressure inside the bowel, thus preventing regurgitation of the bowel contents into the ureter itself (*Figs.* 122 and 123).

The next step consisted in the employment of ureteric catheters, which were tied into the ends of the ureters and were passed into the bowel, so that for ten days or thereabouts the secretion from the kidneys could be assured of a free passage without the temporary obstruction which sometimes arises as the result of œdema about the anastomosis.

The final problem which Coffey set himself to solve was the prevention of infection from the bowel lumen, and his latest technique (which has been described[8] since the delivery of the Hunterian Lecture) includes a method by which he attempts to sterilize the lower segment of the bowel before the
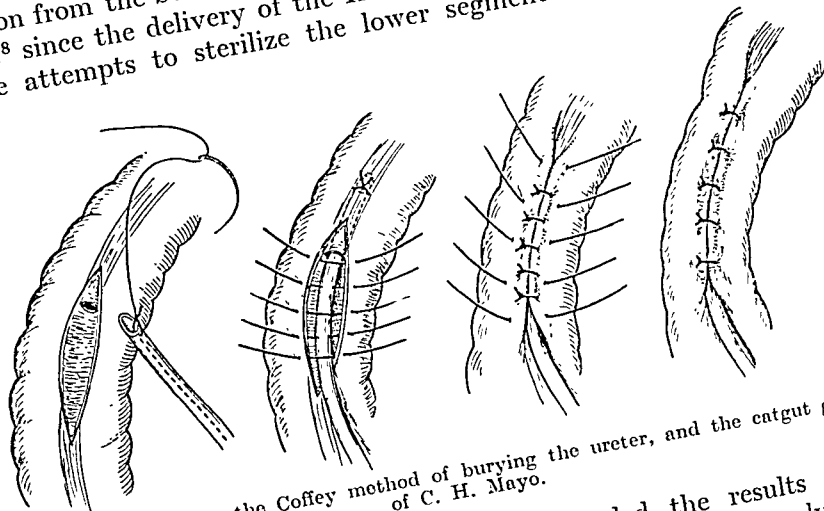
FIG. 121.—Shows the Coffey method of burying the ureter, and the catgut guide of C. H. Mayo.

implantation is carried out. Coffey has recorded the results of 9 cases operated upon by his completed technique. One patient was only 20 months old at the time of double implantation of the ureters for ectopia. This operation was carried out a year before publication, and the patient was in good health and without evidence of renal infection. The other 8 cases operated upon appeared to be equally satisfactory. His important papers should be carefully perused by anyone interested in this particular problem.
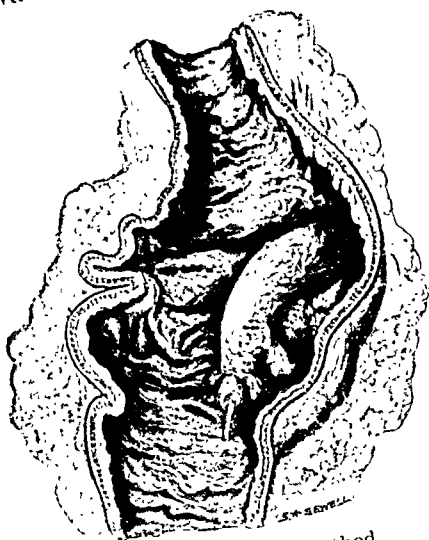
FIG. 122.—Coffey method.

Showing the result of operations carried out on the fresh cadaver. In both cases a fine wire has been passed through the ureter to demonstrate its orifice in the bowel.

FIG. 123.—Stiles method.

Coffey's results have been so encouraging that, if extended experience in the hands of other operators bears out the work of the originator, then I have no doubt this operation will become the method of choice. In my

experience some degree of infection has occurred sooner or later, and I shall be surprised if any procedure can be devised which can prevent its advent in all cases. The catgut guide of Charles Mayo is probably an advantage, but on the other hand it may be that the submucous position of the ureter recommended by Coffey makes it much less likely to be obstructed in the earlier days.

Most workers have assumed that infection has been directly conveyed to the ureter by regurgitation of the bowel contents, but I believe that this is wanting in proof. In *Case* 13 it was not possible to make any fluid pass up the ureters from the bowel when this experiment was tried with the fresh parts just after death. In fact, in order to distend the ureters sufficiently for the purpose of setting up the specimen, it was necessary to pass a hollow needle into each separately. Yet in this boy both kidneys showed evidence of gross ascending infection. Possibly the infection reaches the ureters and kidneys by means of the ascending mucous currents described by C. J. Bond.[9] In my view it is essential to have an unimpeded opening into the bowel, and anything like obstruction, not even amounting to stricture, is more likely to bear a causal relationship to infection than any other factor. This view would bring it into line with other infections secondary to disease in the lower urinary passages.

THE SEXUAL PROBLEM.

At the outset I stated that the importance of the sexual problems associated with these deformities had early been brought before my notice. At that time it never occurred to me that the grosser forms of anomaly could be sufficiently rectified to restore the sexual functions, and it was with the idea of arresting development of the testicles that I excised portions of the vasa in my first three cases. At that time I was not aware that John Hunter had shown that division of the vas was not followed by atrophy of the testicle, and I am much obliged to Sir Cuthbert Wallace for pointing this out to me. The normal development of the patients whom I treated in this way has certainly shown that the sexual characteristics are not appreciably altered, but as yet I have no means of knowing whether their procreative functions have been arrested.

The general development and well-being of the patients here recorded encourages me to believe that reconstructive operations on the external genital organs may enable the victims to follow the dictation of their natural instincts. With the female patients there seems no barrier either to marriage or maternity, and the wide pelvis and separated symphysis render delivery easy.

AFTER-HISTORY OF SOME OTHER CASES NOT PREVIOUSLY PUBLISHED, AND FROM THE LITERATURE.

Through the kindness of Emeritus Professor Sir Harold Stiles, I am able to publish the after-history of some of his cases of transplantation of the ureters. I have further to thank Professor D. P. Wilkie, who kindly arranged to have the cases traced. This work was carried out by Mr. W. C. Wilson, of the Department of Surgery in the University of Edinburgh, to whom I am greatly indebted for the trouble he has taken on my behalf.

Case 1.—C. D., female. Epispadias. Operation in 1907 at age of 3. Reported well in 1913. At present (January, 1928) aged 23 years, unmarried; in constant employment as a dressmaker. General health excellent. Can retain for five or six hours during the day. Rises once at night to micturate. Very rarely some loss of control and slight escape of urine. Somewhat sensitive disposition.

Case 2.—A. McK., female. Epispadias. Right ureter transplanted. Operation in 1908, at age of 7. Perfect recovery. Seen 5¾ years later. No evidence of renal infection. Perfect control over urine, which she can retain for five to eight hours. Slight proctitis. Very well March, 1914, six years after operation. Not traced since.

Case 3.—R. G., male. Extroversion of bladder. Transplantation of both ureters into pelvic colon. November, 1911, at age of 3. The child made an excellent recovery from operation. The boy died on June 22, 1927, at the age of 19 years. Control of urine seems to have been entirely satisfactory, and apparently there was no complaint referable to the operation. He never showed any signs of puberty. The voice did not break, and at death he was only 3 ft. 6 in. in height. In appearance and development he was as a child of 7 or 8 years. The case-notes state that both testicles were descended. For years before death he suffered from periodic attacks of ' cyclic vomiting'. Death occurred in one of these attacks. The terminal illness was apparently marked by convulsions, and according to the doctor it was a very typical attack of cyclic vomiting.

Case 4.—E. S., female. Epispadias. Operation in 1913 at age of 3. At present (January, 1928) aged 18 years; unmarried. Employed as cakebaker. Condition does not interfere with employment. General health has been uniformly good since operation, and is at present excellent. Can retain urine for five to six hours. Sometimes suffers from lack of control during the night; otherwise perfect control. Is contemplating marriage.

Case 5.—A. S., female. Extroversion of bladder. Right ureter transplanted into the pelvic colon, June, 1919. Left ureter November, 1919, at age of 5. Made excellent recovery from both operations. For some three or four years afterwards there was occasional leak- age of urine from the bowel by day and every three or four hours at night. Could retain urine for a maximum period of five hours. During these years occasional attacks of mild general systemic disturbance with pain in left kidney region and diminished urinary excre- tion. For the past five years condition has gradually improved—now about one in a year. Now, the attacks of pain, etc., have become much less frequent—now about one in a year. Now, January, 1928, nearly nine years after operation, is of slight build and sensitive disposition. General health excellent. Occasional slight lack of control. Passes urine (with fæces) every two hours by day and rises once during the night. Can retain urine for five hours fairly easily.

Case 6.—J. N., male. Epispadias. Age 7 at time of operation. Previous to this had undergone numerous operations on neck of bladder with no success in establishing any control. Right ureter transplanted January, 1920 (technique modified in that opening of ureter was enlarged by longitudinal incision). Ureter came adrift from bowel about a week later. At further operation (April 24) ureter could not be brought down to pelvic colon, and a fistula was made to anterior abdominal wall. To relieve this condition the right kidney was removed on Oct. 25. Further operation not advised. Patient brought back four years later and earnest request made for operation, since life with incontinence was proving unbearable. Left ureter transplanted May 16, 1924 (by Coffey method). No urine passed after operation. Died in uræmic convulsion on May 21.

Mr. Robert Purves, of Lincoln, operated upon a case by the method of Stiles, and he has very kindly sent me the following notes together with the after-history.

J. W. L., male, age 31, was admitted to the County Hospital, Lincoln, on Oct. 22, 1922, for ectopia vesicæ and epispadias. The patient stated that he had always passed urine through the abdominal wall, and that, being continually wet, he had suffered very much from excoriation of the skin, which had rendered him less and less able to get about, so that he had been confined to his bed for the past twelve years.

His condition on admission to hospital was that of a frail, anæmic man. There was marked pyorrhœa, and much deformity from his prolonged residence in bed in a faulty attitude. The left hip was flexed 120°, externally rotated and abducted. The knee of the same side was flexed 100°. The right hip was also flexed to a like extent, internally rotated and adducted, and the corresponding knee was flexed to a slightly less extent. The whole spine was curved antero-posteriorly, and also to the left, the costal margin

touching the iliac crest. Both abdominal recti muscles ʺ .. · · · , ̶ ̶ ̶ ̶ ᵈⁱ ̶ ̶ ̶ ̶ ʳ contracted. He had a well-marked ectopia vesicæ with complete ·; ·· ·., | ·.. surrounding the bladder and that of the groins was much excoriated, with marked proliferation of the epithelium. This skin and the mucous membrane of the bladder were very sensitive. X rays showed failure of fusion of the pubic arch. The testicles were normally descended, and there were no signs of any other congenital deformity, while he was said to be sexually fully developed.

It was decided to treat the condition by transplantation of the ureters after the method of Stiles, and on Oct. 24, 1922, he was put on a mixture containing urotropine and acid sodium phosphate, by way of preparation. Two days later the right ureter was transplanted into the pelvic colon through a right rectus incision. The patient passed urine per rectum the morning after the operation. Four days later, on Oct. 30, he was given a pill of methylene blue, and the colour was well exhibited in the motions. Urine was passed per rectum at two-hourly intervals during the day, and every four hours during the night. A few days later he was able to go as long as four hours during the day, and during the night he was only disturbed twice. In another week the day period had increased to five hours.

On Nov. 15, twenty days after the first operation, the left ureter was transplanted. There was considerable difficulty in approach owing to the contracted condition of the left rectus. The right ureterocolic anastomosis was found to be sound, and no adhesions were encountered. Five days later the patient was passing urine per rectum four-hourly during the day, and a fortnight later he was able to hold his urine in the rectum as long as four and a half hours, but he had some incontinence.

All his teeth were extracted three weeks after the second operation, and on Feb. 14, 1923, he was discharged from the hospital. He had good control of the urine, but there was much moisture from the exposed mucous membrane of the bladder. As this moisture was coloured blue after the exhibition of methylene blue, the presence of a third ureter suggested itself.

Three and a half months later, on May 28, the patient returned to hospital for treatment of the ectopia and epispadias. He occasionally had some urine passing through the bladder, but was dry for more than a week at a time. Urine was being passed per rectum three-hourly. Three days later, on May 31, the posterior wall of the bladder was freed all round except for a pedicle below. The mucous membrane of the floor of the urethral furrow was divided from the skin margin of the penis, and the bladder wall was turned down and sutured to the edges of the urethral mucous membrane so as to form a roof to the urethra. The skin edges of the abdominal and penile wounds were then united each to each. Six days later the patient passed some urine through the new urethra. The abdominal wound had given way a little at the upper extremity, but was granulating well, and he was discharged on June 21. He refused to have any treatment for the correction of the deformities of the legs, but their positions were somewhat improved from those present on his first admission.

Two years later Mr. Purves visited this man at his home. He had complete control of the rectum, with evacuation every four to four and a half hours, and had then been dry for twelve months. He was getting about well with crutches, and frequently rode several miles on a bicycle. He had started work as a boot repairer. Though still very pale, he was fatter and much healthier-looking than before.

NOTE.—Dr. E. Barry Denny reported that J. W. L. died of pneumonia on Nov. 21, 1925, after six days' illness. No evidence of renal infection was observed then or previously. There was no post-mortem examination.

Through the kindness of Mr. Lawford Knaggs I am able to append the following note on the subsequent history of an adult female, whose case was fully and most carefully recorded by him[10] under the following title : " On Implantation of the Ureters into the Rectum by the Sacral Route, Illustrated by a Case of Inveterate Vesico-vaginal Fistula in which the Left Ureter was Implanted and the Right Kidney Removed ".

The patient, 42 years of age, was admitted to the Leeds General Infirmary in February, 1909. Five years previously, during a difficult confinement, she was so much torn that the bladder and vagina were converted into a single compartment. For the cure of her miserable condition she had submitted to thirteen operations before she came under the care of Mr. Knaggs.

This surgeon gave very careful consideration to the case, and finally worked out a plan for implantation of the ureters by the sacral route. On account of the extraordinary amount of scar tissue only one ureter could be dealt with as intended, and subsequently the

opposite kidney was removed. Eventually the patient made a complete recovery and went to her own home. Seven months later she reported herself as very well and able to retain urine for about three hours. Sometimes at night there was a little incontinence if she happened to sleep unusually soundly. Three years later she was again in hospital for the treatment of a prolapse of the exposed mucous membrane of the bladder through the vesico-vaginal fistula. This was corrected by plastic operations. In October, 1927—that is, eighteen years after the implantation of the ureter—she reported herself as very well, with no pain or bad effects from the operations, and able to work well looking after her own house. At no time have there been any symptoms suggesting infection of the kidney.

In 1909 Sir Arthur Ball,[11] of Dublin, recorded the case of a boy 5 years of age, the victim of ectopia vesicæ, upon whom he had operated in July, 1908. The ureters were implanted into the rectum by the Lendon-Peters method, and subsequently the mucous membrane of the bladder was removed. Sir Arthur very kindly traced this patient for me, and he reports that now, twenty years after the operation, he is still well and strong, with good rectal control, and able to earn his own living.

The following statistics have been extracted from one of the latest papers on the subject from the Mayo Clinic.[5] I have often discussed the matters under consideration with Dr. Charles Mayo, and I am much obliged to him for several personal communications, and especially for his kindness in drawing my attention to the value of the catgut urine guide.

MAYO CLINIC STATISTICS.

From 1901 to April 1, 1926 :—
71 Cases operated upon—
  Plastic operations only .. .. 8 cases
  Transplantation of both ureters .. .. .. 46 ,,
  Transplantation of one ureter.. .. .. .. 10 ,,
  Exploration only .. .. 2 ,,
  Moynihan's operation .. .. 2 ,,
  Coffey's operation .. .. 3 ,,
11 Deaths from operation (16·6 per cent)—
  5 from peritonitis, 4 from septic kidney, 2 from renal insufficiency.
7 Late deaths,
  2 months to 12 years after operation. Only 1 due to renal complication.
29 Ureter transplants reported as to after-results—
  25 satisfactory, 2 poor control, 1 has incontinence.
  These patients are alive and well from 1 to 15 years after operation.

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SHORT NOTES OF
RARE OR OBSCURE CASES

A CASE OF HÆMATURIA ARISING FROM ONE SEGMENT OF A DOUBLE KIDNEY, TREATED BY RESECTION.

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THE following case appears to be worth recording :—

Miss B., a woman, age 40, was admitted to Glasgow Royal Infirmary with a history of continuous hæmaturia of five months' duration. The bleeding was unaccompanied by pain, colic, or other urologic symptoms, and the general examination was negative. The urine was deeply blood-stained, contained no casts, and was sterile. On cystoscopy two ureteric orifices were observed on the left side, situated on a common ureteral ridge. The efflux from the outer and higher orifice was deeply blood-stained, whereas that from the inner and lower one and also that from the right ureteric orifice were clear. An estimation of the renal function by the indigo-carmine test revealed no impairment, a strong blue efflux appearing at the three ureteric orifices within four minutes of intravenous injection.

Subsequently the three ureters were catheterized, and a pyelographic examination was carried out : the right pelvis was first distended with the opaque fluid, and immediately thereafter the two pelves on the left side were filled.

FIG. 124.—Bilateral pyelogram. The upper and inner pelvis on the left side is nearly empty. The lower and outer one is normal in appearance. On the right side the pelvis is of the bifid type.

After taking the pyelogram (*Fig.* 124) it was found that the upper and inner left pelvis had almost evacuated its contents ; this was therefore distended once more, and another X-ray photograph taken (*Fig.* 125). It will be seen that the two pelves on the left side are completely separated from one another and occupy different levels. The superior and inner one

is the smaller, and practically consists of two calices ; the lower and outer pelvis is normal in appearance ; that on the right side is of the bifid type. The examination thus showed that a complete reduplication of the pelvis and ureter existed on the left side, and that the source of the hæmaturia was confined to the lower portion of that kidney, although the cause of the hæmaturia was not made apparent. As no spontaneous diminution in the bleeding was observed, it was decided to resect the affected portion.

OPERATION.—The kidney was exposed and delivered through a curved lumbar incision. A shallow groove was observed in the kidney proper, passing from the lower part of the hilum in front to the convex border just below its mid-point. The groove was not continued on to the posterior surface. The resection was commenced by ligating and dividing the vessels running to the lower part of the kidney. The lower segment was then separated from the upper by an incision which was made to pass through the groove mentioned above. The outer ureter was next divided, and the lower segment removed. There was surprisingly little hæmorrhage from the cut surface of the upper segment, and it was readily controlled by deep mattress sutures, which were passed through the kidney substance. A rubber-tube drain was placed below the cut surface of the kidney and brought out through the upper angle of the incision, which was then closed.

AFTER-HISTORY.—The hæmaturia disappeared within twenty-four hours of the operation. Some considerable leakage of urine took place through the tube during the four days that it was allowed to

FIG. 125.—Skiagram taken after the upper and inner pelvis had been refilled.

remain in position, and after removal of the tube this continued through the opening which had been left at the upper end of the wound. The rest of the wound healed by first intention. The patient was sent to the convalescent home three weeks after operation, by which time the leakage had almost ceased. She returned to hospital two weeks later, however, with a profuse urinary discharge. This was again confined to the original drainage opening, the rest of the wound having remained intact. The patient was re-admitted, confined to bed, and put on urinary antiseptics. The discharge ceased and the fistula closed in ten days. An indigo-carmine functional examination was then carried out, and within four minutes of intravenous injection a strong blue was observed coming from the left inner ureteric orifice and also from the right one. There was no recurrence of the hæmaturia.

PATHOLOGICAL FINDINGS.—For the following account of the findings in the resected portion of the kidney (*Fig.* 126) I am indebted to Dr. Helen Wingate.

Ward Specimen No. 1914. *Lower Half of Left Kidney.*—On splitting the portion of kidney removed, a small area of hæmorrhage is evident at the apex of one of the calices, and its appearance suggests the presence of an angioma. Microscopic examination, however, proves it to be an interstitial hæmorrhage, associated with a considerable round-celled infiltration. The renal parenchyma shows early chronic changes. These are well-marked in the glomeruli, some of which are swollen and adherent to Bowman's capsule, while others

FIG. 126.—Photograph of the resected portion of the left kidney. The arrows point to the area of hæmorrhage, which is immediately adjacent to a calix. The macroscopic appearance suggested a hæmangioma.

show commencing fibrosis, and a few are comparatively fibrous. In many cases Bowman's capsule is thickened, and in some cases hyaline. The tubular epithelium shows intense cloudy swelling and some catarrh. The renal vessels are unduly thick.

Comment.—Chronic nephritis may be present without there being any clinical evidence of that condition. Probably in many cases it is the underlying cause of so-called 'idiopathic or essential hæmaturia', and should be suspected in a case of hæmaturia if no other cause for the bleeding can be ascertained after a complete urologic investigation. Long-continued hæmorrhage may necessitate nephrectomy to save the patient's life. In this case, as the result of the pre-operative investigation locating the source of the hæmaturia to one segment of a double kidney, it was possible to plan a conservative operation and to remove only the offending portion of the organ.

CONGENITAL DIVERTICULUM OF THE STOMACH IN AN INFANT.

By NEIL SINCLAIR.

SURGEON TO THE EVELINA HOSPITAL FOR CHILDREN, LONDON.

THE following case seems worthy of record :—

In May, 1928, a male infant, age 4 months, was admitted to the Evelina Hospital with symptoms suggesting intussusception—that is, vomiting and the passage of blood by rectum. For five weeks the child had attended the out-patient department for wasting and constipation. The vomiting and passage of blood had been present for only a few hours before admission; the vomit from time to time contained bright blood in small quantities. The child's general condition was poor, and considerable wasting was present. A small rounded tumour was felt in the left upper abdomen and was also palpable by a finger in the rectum.

At operation performed the same day no intussusception was found, but from the region of the duodenojejunal flexure protruded a globular tumour, a little larger than a golf ball (*Fig.* 127). This was plum-coloured and tense, and had a short but well-defined pedicle which passed above the duodenojejunal flexure and was attached intimately to the under-surface of the transverse mesocolon just above the flexure. Its surface was covered by a thin vascular film of peritoneum apparently derived from the mesocolon. The pedicle did not appear to be attached to the colon, duodenum, pancreas, or stomach, all of which were carefully examined. The tumour was opened: its wall was thick and deeply congested and its cavity contained dark blood and mucus. A thick rugose mucosa was present. The pedicle, though not apparently twisted itself, was very intimately connected with the mesocolon, which seemed to be constricting it. Owing to the poor condition of the child it was not deemed advisable to trace the pedicle

FIG. 127.—Relations of tumour as found at operation. A, Transverse colon thrown back; B, Splenic flexure; C, Transverse mesocolon; D, Duodenum; E, Tumour; F, Jejunum; G, Descending colon.

further by dissection; it was accordingly divided and the stump oversewn. No lumen was visible while this was being done. The colon, duodenum, pancreas, and stomach were all again examined and appeared normal. Operation shock was severe, but the child made an uninterrupted recovery, and was, some eight months later, well and strong.

Naked-eye examination of the tumour afterwards showed a globular sac with well-developed muscular coat and a thick mucosa resembling that of the stomach. Opposite the pedicle on the inner side was a depression from which a fine probe passed easily into the pedicle. Further examination of the pedicle confirmed the impression formed at operation that no twisting had occurred.

A month after operation the child was given a barium feed and the stomach was X-rayed by Dr. Henderson, Radiologist at the Evelina Hospital; the radiographs show an apparently normal stomach.

Microscopic sections made of the wall of the tumour by Dr. Elworthy, Pathologist to the West London Hospital, and by Mr. T. P. Lawrence, of the Royal College of Surgeons Museum, show that its structure is identical with that of normal stomach (*Fig.* 128). Oxyntic cells are present. The specimen is preserved in the Museum of the Royal College of Surgeons.

I am indebted to Sir Arthur Keith for the following remarks on the condition :—

" 1. As to the nature of the cyst there can be no doubt; it reproduces the exact structure of the stomach and therefore one infers it arose from that organ.

Fig. 128.—Microscopic section of tumour. A, Mucous membrane; B, Muscularis mucosæ; C, Submucous layer; D, Transverse muscle with fibrous tissue; E, Subperitoneal tissue.

" 2. There was no food in the cyst, therefore its lumen had no open communication with that of the stomach.

" 3. A diverticulum arising from the dorsal border of the stomach, during the second month of development would be included in the dorsal

mesogastrium, where it would lie near or beside the pancreas, and when the omental sac is developed would come to be in the posterior wall of that sac. I infer that the cyst described here has arisen thus.

" It is clear that the circulation of the cyst became obstructed in some way and a state of threatened gangrene set in. The symptoms of obstruction were apparently of reflex origin ; when the cyst was removed they disappeared. I have not come across such a specimen as this before, but I know records of such have been made—although they are rare."

CONCLUSIONS.

1. The specimen appears to be one of true congenital diverticulum of the stomach. It was not possible at operation or by subsequent X-ray examination to determine its exact site of attachment to the stomach.

2. The symptoms which led to operation were presumably due to an increasing constriction of the pedicle by the transverse mesocolon through which the diverticulum had passed (or around which the mesocolon had developed).

3. There was no evidence of torsion of the pedicle.

A CASE OF OSTEOMYELITIS OF THE SPINOUS PROCESS OF A DORSAL VERTEBRA.

By S. J. HARTFALL and L. B. HESELTINE,

THE GENERAL INFIRMARY, LEEDS.

THE case reported is one of considerable interest, illustrating the difficulties of diagnosis in a condition of acknowledged rarity yet of gross pathology as revealed at autopsy.

HISTORY.—The patient, a boy, age 8 years, was admitted to the Leeds General Infirmary with the following history. He was quite well until three days before admission, when, shortly after bathing in the sea, he complained of a dull pain in the middle of the back, and vomited bilious material. Both symptoms continued for two days, and on the third day a doctor was consulted. He diagnosed '? meningitis' and advised admission to hospital.

ON ADMISSION.—On the day of admission the vomiting ceased and did not recur. The child's temperature was 101°, pulse 132, respirations 36. He lay perfectly still and looked acutely ill. His mental condition was quite normal; he answered questions intelligently and promptly. The face was flushed a little and somewhat expressionless. There was no headache, squint, or ocular disturbance of any sort, but there was notable rigidity about the neck, and Kernig's and Brudzinski's signs were positive. No sensory changes were present, tendon reflexes were normal, and the plantar reflex was flexor. The only other obtrusive feature was the intense hyperæsthesia which seemed to extend over the whole length of the spine and was maximal in the lower

dorsal and lumbar regions. The skin and subcutaneous tissues in this situation appeared normal.

A lumbar puncture was performed; the fluid was under slightly increased pressure and of a faint turbidity. Cytological examination showed slight excess of cells, which were polymorphs. No growth was obtained on culture. A radiograph of the spine was negative.

SUBSEQUENT COURSE.—The child's condition grew steadily worse; there was a persistent remittent and intermittent temperature, opisthotonos, and spinal hyperæsthesia so extreme that he could not bear to have his back touched, and cried out if the cot were jarred.

A second lumbar puncture was attempted; only a few drops of yellowish fluid were obtained, however, again with excess of polymorphs. Further attempts at lumbar puncture were made, but never was fluid obtained.

On the seventh day of the illness the temperature stood at 103° and the child became delirious for the first time; the back arched almost to a semicircle. Towards night it became obvious that the patient would not survive many hours. He died early in the morning, the temperature rising to 107°.

POST-MORTEM FINDINGS.—On incising the muscles on either side of the spinous processes in the dorsal and upper lumbar region, thick yellow pus escaped in considerable quantities. It appeared to be occupying the fascial spaces between the various muscles composing the posterior spinal group, and seemed to originate from the region of the 6th dorsal spine. Further dissection revealed this process and its laminæ stripped bare of periosteum and having a dead white appearance, in marked contrast to the processes above and below it. The tip, on its lower edge, was eroded and the bone here was soft, and crumbled on scraping with a knife. By pressure pus could be made to exude from the spinal canal through the interlaminar membrane (ligamentum subflavum) above and below the affected vertebra.

On removal of the spinous processes by sawing through the laminæ, the spinal dura was found to be firmly attached to their inner aspects and was congested, rough, and perforated at one or two points, while the ventral portion of the dura was free, entirely unattached, and not obviously inflamed. Thick yellow pus was found to occupy the whole length of the spinal canal from bulb to cauda equina. The bodies of the vertebræ were healthy. The brain and membranes appeared normal and there was nothing of interest elsewhere. Films of the pus showed numerous staphylococci, and on culture a pure growth of *Staphylococcus aureus* was obtained.

We are indebted to Dr. W. Vining for permission to publish this case.

REVIEWS AND NOTICES OF BOOKS.

The Art of Surgery : A Text-book for Students and Practitioners. By H. S. SOUTTAR, D.M., M.Ch. (Oxon.), F.R.C.S. (Eng.), Surgeon to the London Hospital. Crown 4to. Pp. 624 + viii, with many illustrations, some in colour. 1929. London : William Heinemann (Medical Books) Ltd. 30s. net.

WHETHER surgery is an art or a craft is a debatable point. Perhaps the truth is that, as in many other vocations, it is a combination of the two that produces the ideal. Add to the perfected skill of the craftsman the imagination and breadth of view of the artist and we have a man capable of steering the ship of knowledge into unexplored waters and of charting the way so that others may follow.

Mr. Souttar's *Art of Surgery* strikes us as the work of a craftsman rather than of an artist. He has set out to lighten the burden of the student by omitting what is not essential and describing very fully what is fundamental. We can hardly say that in this he has entirely achieved his object, for he has tended in places to give details at the expense of fundamentals. There are thirteen pages on cerebral tumours alone, while the whole of cerebral and head injuries is dispensed with in a matter of ten pages.

The system of marginal illustrations by line drawings has much in its favour, as it avoids breaking up the text and diverting the reader's attention. The majority of these drawings are self-explanatory, but some, we feel sure, will convey but little to the student, and those on hernia he will find perplexing. The four marginal sketches on page 245 have puzzled us in endeavouring to interpret them. The section on diseases and injuries of nerves is excellent and the drawings are good, but surely a detailed account of the injection of the Gasserian ganglion for trigeminal neuralgia is superfluous.

There are a number of references to comparatively rare conditions, such as the gravitation paraplegia of Thorburn and Mikulicz's disease, while there is no mention of spinal shock or mixed parotid tumour. In a book of this nature the author is bound to be dogmatic, so that the practising surgeon may not find himself in agreement with all the statements made ; but to the student just beginning the study of a subject, dogmatism is infinitely preferable to a confused mass of theories, the truth or otherwise of which he has no opportunity of testing. However, few will agree with Mr. Souttar when he says that in the absence of a palpable tumour the case is probably not one of intussusception ; that diaphysectomy in osteomyelitis is often necessary ; or that the operative treatment of congenital dislocation of hip is seldom successful. The section on the abdomen is simple and well balanced ; but we would impress on the student that fæcal vomiting is rather a sign of impending death than of intestinal obstruction.

We have the impression that Mr. Souttar has aimed at originality and uniqueness, and we congratulate him on his success in this ; but we think that Billroth's description of tuberculous granulation tissue as being like ' ivy on a wall ' is preferable to the author's ' lichen on a stone '.

The student will find the book pleasant and easy to read, and he will be the better for its perusal, covering as it does the main facts of the subject. We cannot say that it will supplant his usual text-books, but he will find it a useful introduction to the subject.

Surgery in the Tropics. By Sir FRANK POWELL CONNOR, D.S.O., F.R.C.S., D.T.M. and H., Lieut.-Col. I.M.S., Professor of Surgery, Medical College of Bengal, Calcutta, and Surgeon to the College Hospital. Post 8vo. Pp. 293 + ix, with 99 illustrations. 1929. London : J. & A. Churchill. 12s. 6d. net.

SURGERY in the tropics necessitates a knowledge not only of those surgical diseases and their complications which are rare elsewhere, but also of the modifications which general surgical methods must necessarily undergo to adapt themselves to the peculiar features of tropical environment. It is to the former that the author has almost entirely devoted this book of 300 pages, although he foreshadows the possibility of a future opportunity of directing attention to the latter. He points out that the steadily increasing use of aerial transport, with its rapidity of travel, is likely greatly to extend the area in which 'tropical' diseases will be encountered in the future ; it will then be necessary for all medical students to receive instruction therein. The author is to be congratulated on having been able to describe so many tropical diseases within his restricted space, though doubtless opinions will vary as to whether the best possible apportionment has been obtained. The important subject of plague is very summarily dismissed, whereas an excellent account is given of liver abscess and its treatment, stress being laid on the great change of outlook that has resulted from the introduction of emetine.

Errors are very few, though on page 88 'ileo-sigmoidoscopy' should read 'ileo-sigmoidostomy'. This book should be studied by all those who intend to practise in tropical regions.

Neurosurgery : Principles, Practice, and Treatment. By WILLIAM SHARPE, M.D., Professor of Neurosurgery, New York Polyclinic Hospital and Post-graduate Medical School, etc. ; and NORMAN SHARPE, M.D., Attending Neurosurgeon, St. Mark's Hospital and Hospital for the Ruptured and Crippled. Medium 8vo. Pp. 762 + xxxvii, with 208 illustrations in black-and-white, and 5 in colours. 1928. London : J. B. Lippincott Co. 42s. net.

THE presentation of a large volume devoted to the problems of neurosurgery testifies eloquently to the growing importance and complexity of this particular specialty. Within these lavishly illustrated pages the authors deal with the theory and practice of the surgery of the brain, the spinal cord, and the peripheral and cranial nerves ; the surgery of the sympathetic system is not considered. It must be confessed, however, that this presentation of neurosurgery falls very short of the ideal, and despite its length, cannot be considered as an exhaustive—or even adequate—monograph. Clinical and pathological details of brain tumours are treated very sketchily, though the authors give a useful discussion on the so-called 'pseudo-tumour' or 'wet-brain'. The chapters on cranial injuries are good, and the value of spinal manometry is emphasized as an early indication for operation. " Chronic brain injuries " are well discussed, and it is shown that two-thirds of a series of patients discharged from hospital with the diagnosis of fractured skull in the decade 1900–10 subsequently showed persistent cerebral disturbance. Brain trauma in infancy is next discussed, but its importance in the etiology of Little's disease is probably exaggerated. The chapters on spinal tumours are good, and it is interesting to note that the dangers of lipiodol as a routine diagnostic aid are stressed. But when we read that " no unfavourable case-reports have been found in the literature " we are shown merely the inadequacy of the authors' search. There is some confusion of thought expressed in the paragraphs on the chemistry of the spinal fluid, especially where it is stated that in regard to albumin " its presence in the normal fluid has been disputed by some ; at any rate it is present only in minute quantity."

Most British surgeons and neurologists—while agreeing with the authors in their praise of resection of the sensory root of the Gasserian ganglion for trigeminal neuralgia—will profoundly disagree with their condemnation of alcoholic injection into the ganglion as a therapeutic measure. Nor will they subscribe to the authors' operation of peripheral neurectomy for trigeminal neuralgia localized to one division. Treatment of general paralysis by the intraventricular injection of salvarsanized serum is described, and details are given of the authors' experimental work with the introduction of dyes into the cerebrospinal circulation of animals. The most

extraordinary and indefensible point of all, however, is that the authors advocate laminectomy as a deliberate form of treatment in cases of disseminated sclerosis. To argue that marked improvement has followed such measures means nothing to those with experience of this disease.   No reference is made in this book to the operation of chordotomy or to the treatment of intractable pain and gastric crises by spinal ramisection.

Ulcères de l'Estomac et du Duodénum. By VICTOR PAUCHET, GABRIEL LUQUET, and A. HIRCHBERG. Crown 4to. Pp. 354, with 309 illustrations. 1929. Paris: Gaston Doin et Cie.   13s. 9d.

VICTOR PAUCHET has the gift of exposition and commands the services of an artist whose pen technique is extraordinarily striking in its beauty and effectiveness. The usual arrangement of a work such as this has been reversed, in that the operative details and clinical management of patients are considered first, this part being written in association with Luquet, the pathology and etiological considerations being left for Part II.   This is rather unfortunate because it is apt to magnify the place of surgery in the treatment of gastric ulcer, whereas all thinking clinicians are coming to look upon surgery, essential as it is, as only a necessary temporary phase in the evolution of medicine.   Starting from this basis the surgeon is free to lay down rules for the conduct of cases where medicine now fails.   M. Pauchet is dogmatic but logical in his recommendations.   He states that only one method of suppressing hyperchlorhydria is known—namely, a large pylorogastrectomy—and he sees in this fact the only pointer to effective treatment of ulcers of the stomach or duodenum associated with excess of acid.   He declares himself for this reason a partisan of resection à outrance in ulcer.   Rightly he says it is no argument against resection that the operation is difficult.   He disposes of the mortality argument by comparing his own mortality of 4·9 per cent for gastrectomy with that of hysterectomy for myoma, which is the same and is not usually considered a very serious procedure.

Gastrojejunostomy, Balfour's operation, annular gastrectomy have all been found unsatisfactory in his hands.   Whenever possible he performs pylorogastrectomy for ulcer of the duodenum when accompanied by hyperchlorhydria, and always for gastric ulcer from fear of cancer supervening.   For duodenal ulcer with low acid content he performs a simple gastrojejunostomy.   The descriptions of difficult gastrectomy and duodenectomy operations are admirably clear.   To get free access, he seems prone to make an L-shaped incision of the abdominal wall without hesitation.

With regard to post-operative hæmorrhage as a complication of gastric surgery, the interesting statement is made that if gastric lavage and a blood transfusion do not suffice to stop it, any attempt at re-opening the abdomen and active hæmostasis is doomed to failure.   The author says that in such circumstances there is nothing to do but stand by and watch the patient die.

In the section on the treatment of hæmorrhage from the ulcer itself the logical course is recommended of operating to remove the ulcer as soon as and whenever the condition of the patient will allow.   But it is not easy to understand quite how this decision is to be made.   Pauchet brings forward again his view that very severe and fatal poisoning from the absorption of the products of digestion of the patient's own blood takes place, so that after removal of the ulcer it is necessary to wash out the contents of the colon, for which a cæcostomy is most effective.

Part II is written by Hirchberg.   It reviews the pathology and anatomy of ulcers of the stomach and gives numerous statistics.   It is a satisfactory account on ordinary lines.   This book and its companion volume on gastric cancer already reviewed in our pages are two attractive works on gastric surgery.

Chirurgie de l'Estomac et du Duodénum. By HENRI HARTMANN, Professor of Clinical Surgery, Paris. Part II (7th Series of Works on Surgery). Imperial 8vo. Pp. 340, with 142 illustrations. 1928. Paris: Masson et Cie. Fr. 60.

THIS book is a collection of chapters on the surgery of the stomach and duodenum, some of which are written by Professor Hartmann and some by his assistants at

the Hôtel-Dieu, Paris. Although the material is good throughout, probably the most instructive part of the book is the large number of cases which are quoted in connection with each section and which are followed up, in some cases for many years, after operation. It is from a consideration of the after-results that the discussion on treatment is based, and, as might be anticipated, it is highly instructive. There is a particularly detailed discussion of the chronic gastric ulcer, its microscopical appearance, and the question of its being the precursor of carcinoma ; it is interesting to find that of 187 cases of gastric ulcer treated by a short-circuiting operation, 4 subsequently died of carcinoma of the stomach. We do not agree with the statement that the pyloric vein is not a reliable guide to the pylorus, and that to call every ulcer to the left of it 'gastric' and to the right of it 'duodenal' is to base the differentiation on an anatomical structure which is unreliable. In our experience the pyloric vein is remarkably constant in its position.

There is an especially good section on chronic obstructions of the duodenum, their cause and treatment, and attention is drawn to the fact that cases may be diagnosed as duodenal ulcers and treated by gastro-enterostomy. In several of the cases quoted this took place, and at a second operation the true state of affairs was recognized and relieved by a duodenojejunostomy. It is pointed out that the two conditions may co-exist, and that the ulceration is in all probability secondary to the obstruction, and, working from this, the suggestion that all duodenal ulcers should be treated by duodenojejunostomy is discussed, but eventually rejected.

Jejunal ulcers are not considered in any detail, which is perhaps unfortunate, as the formation of a jejunal ulcer after a gastro-enterostomy is certainly the greatest criticism of that operation.

The book is well illustrated, and is an exceedingly good and careful analysis of the gastric and duodenal cases occurring in the practices of the surgeons at the Hôtel-Dieu.

Diseases of the Gall-bladder and Bile-ducts. By EVARTS AMBROSE GRAHAM, M.D., WARREN HENRY COLE, B.S., M.D., GLOVER H. COPHER, M.D., and SHERWOOD MOORE, M.D. Second printing. Large 8vo. Pp. 477 + xv, with 224 illustrations in the text and 7 plates. 1929. London : Baillière, Tindall & Cox. 35s. net.

THE fact that a modern surgeon needs to be something more than a mechanic is made evident by the publication of this work, for although written by three surgeons and a radiologist, it contains the most complete account of the physiology and function of the gall-bladder and ducts that has yet been written. The need of such a work has long been felt, and that the want is now supplied is shown by the fact that the first edition was only published in 1928. Such controversial points as the methods of emptying the gall-bladder, the presence of a sphincter at the opening of the bile papilla, the possible paths of infection of the gall-bladder, and especially the value and methods of use of cholecystography, the discussions of which hitherto have had to be sought in widely scattered journals, are here considered under one cover. The opening chapters are devoted to a lucid anatomical discussion of the gall-bladder and the extrahepatic bile-ducts, and include a useful account of the many variations which are so often a source of difficulty to the practising surgeon. A detailed account of the physiology of the gall-bladder follows, and the many points which are still in doubt are carefully considered. The vast literature that has arisen around the question as to how the gall-bladder empties is carefully dissected and considered, and the authors' conclusions are stated.

The preliminary chapters are followed by a full account of cholecystitis, including the interesting condition known as the strawberry gall-bladder. The arguments in favour of the different possible paths of infection are considered at length. The varieties of gall-stones, their etiology and the methods of formation, are fully described, but it is disappointing to find that stones impacted in the intestine are stated to give symptoms similar to those due to other causes, no reference being made to Barnard's famous description of the classical symptoms. The clinical aspects of cholecystitis are well presented, with a valuable description of the less well recognized symptoms of chronic cholecystitis unassociated with calculi.

It is still accepted that, because cholecystitis is most commonly found in married women who have had children, pregnancy has had something to do with their formation, although no controlled figures have ever been published to show what proportion of women between 40 and 50 who have not got cholecystitis are married and have had children.

The chapter on icterus and cholangitis will be found of exceptional value, as this subject is but briefly discussed in the majority of text-books.

A large proportion of the volume is given over to a consideration of chole-cystography, and since it comes from the pens of the introducers of the method it is at once the most complete and most authoritative account of the procedure. No one who is interested can afford to be without these sections. A curious statement is made, however, that it is doubtful if concentrated bile will give an X-ray shadow, whereas with carcinoma of the common duct the pigment calcium in the gall-bladder may be so concentrated that it may be regarded as a soft pigment calculus and may give a well-marked direct shadow of the gall-bladder. There follows another long section devoted to the consideration of the tests of liver function, which, although perhaps outside the scope of a text-book devoted to the gall-bladder and ducts, adds considerably to its value. In the remaining 60 pages there is a discussion of the surgical treatment of the lesions of the gall-bladder and ducts. This section is much less complete in detail and does not appear to have the same authoritative air as the rest of the work. The book as a whole forms a most valuable treatise which no physician, surgeon, radiologist, or clinical pathologist can afford to be without. As a presentation of valuable research work and as a comprehensive review of modern literature it is a credit to the surgery of the United States of America.

Chirurgie des Voies biliaires: Spiro-cholecystostomie. By C. SOBRE-CASAS, Chef du Service de Gynécologie de l'Hôpital Torcuato de Alvear (Buenos Aires). With a Preface by Professor J.-L. FAURE. Demy 8vo. Pp. 119, with 33 illustrations. 1928. Paris: Masson et Cie. Fr. 35.

IN the words of the preface this monograph is short, simple, and so well illustrated that the text is nearly superfluous. The story is that of fifty cases of gall-bladder disease in which cholecystectomy might appear to have been indicated, but in which, for reasons of safety, a modified operation was performed without mortality. The modified operation consists of ligature of the cystic duct and artery with: (1) Obliteration of the gall-bladder by a spiral ligature from the cystic duct to the fundus, combined with drainage (spiro-cholecystostomy) ; (2) Excision of the mucous membrane of the gall-bladder combined with the spiral ligature ; (3) Resection of the anterior or posterior wall of the gall-bladder with curettage of the mucous surface left behind. These procedures are intended to supply a safe and yet adequate means of radical cure of gall-bladder disease.

The monograph is very beautifully illustrated with 33 coloured sketches. Such argument as is brought forward is only that of mortality ; nothing is said of the quality of recovery and persistency of cure after the modified operations described. The monograph is of interest, but probably not of great utility.

Fractures and Dislocations. By PHILIP D. WILSON, A.B., M.D., F.A.C.S., Instructor in Orthopædic Surgery, Harvard Medical School; and WILLIAM A. COCHRANE, M.B., Ch.B., F.R.C.S. Edin., University Tutor in Clinical Surgery, University of Edinburgh. Second edition, revised. Medium 8vo. Pp. 789 + xvii, with 1029 illustrations. 1929. London : J. B. Lippincott Co. 45s. net.

IN the second edition of this eminently practical treatise the authors have wisely refrained from increasing its size to any material extent. Brevity and simplicity have been achieved, however, by the omission of a detailed account of many of the more important complications of fractures. Thus, ischæmic contracture, peripheral nerve and vascular injuries are dealt with somewhat scantily. On the other hand, many sections such as the chapter on spinal injuries are admirably presented.

We note that in the treatment of fractures of the lower end of the humerus, the term 'acute flexion' is still employed, and that this position is illustrated, although the dangers of maintaining contact of the forearm with the upper arm by means of strapping are duly emphasized. In the description of ankle-joint fractures the posterior marginal fracture of the tibia, known to Astley Cooper and Dupuytren, is again referred to as Cotton's fracture. In the treatment of malunited ankle fractures no mention is made of the operation of arthrodesis of the ankle. These minor blemishes do not detract from the value of this competent book, which should continue to be of great service to hospital casualty officers and young surgeons engaged in the routine of fracture treatment.

Elements of Surgical Diagnosis. By Sir ALFRED PEARCE GOULD, K.C.V.O., C.B.E., M.S., F.R.C.S., late Surgeon to the Middlesex Hospital, etc. Seventh edition, revised by ERIC PEARCE GOULD, M.D., M.Ch. Oxon., F.R.C.S. Eng., Surgeon to Out-patients at the Middlesex Hospital, Dean of the Middlesex Hospital Medical School. Pott 8vo. Pp. 730 + xv, with 26 radiographic plates. 1928. London: Cassell & Co. Ltd. 12s. 6d. net.

THE seventh edition of Pearce Gould's *Surgical Diagnosis*, appearing forty-four years after the first, proves that it has withstood the test of time, and it is too well known to require any detailed review.

The present edition differs but little from the previous ones, except in the substitution of an Introduction for the first three chapters of former editions. The increase in the value of X rays as aids to diagnosis is exemplified by mention for the first time of lipiodol, pyeloradiography, and cholecystography, but the book impresses on the student throughout that, despite the advances in scientific medicine, bedside diagnosis by the eye and hand forms the basis of correct surgical diagnosis.

Whether as a book of reference or for systematic reading, we can recommend it to the student, and in it he will find the very fundamentals which will enable him to avoid many of the pitfalls of the examination room.

Surgical Radiology. By A. P. BERTWISTLE, F.R.C.S., late Resident Surgical Officer, General Infirmary, Leeds. With an Introduction by D. P. D. WILKIE, O.B.E., F.R.C.S., Professor of Surgery, University of Edinburgh. Post 8vo. Pp. 142 + xi. Illustrated. 1929. London: J. & A. Churchill. 8s. 6d. net.

THIS is a small book of about 140 pages, having ten sections dealing in a very brief way with the usual text-book physiological systems. It is described by the author as " written to meet the demand for a book on the interpretation of radiograms ", and " from the clinical point of view ", but the preface does not state whether it is designed to supplement the already long list of medical 'Aids' series for students. From its title one would expect great things, but after a careful perusal one can only quote Horace's famous line, *Parturiunt montes . . .*, etc. The 21 illustrations are good.

Handbook of Anæsthetics. By J. STUART ROSS, M.B., Ch.B., F.R.C.S.E., late Lecturer in Practical Anæsthetics, University of Edinburgh; and H. P. FAIRLIE, M.D., Anæsthetist to the Western Infirmary and the Royal Hospital for Sick Children, Glasgow. Third edition. Crown 8vo. Pp. 339 + xvi. Illustrated. 1929. Edinburgh: E. & S. Livingstone. 8s. 6d. net.

No one acquainted with Ross's small handbook will be surprised to see a third edition making its appearance within three years of the first. The book has grown considerably, but the authors have succeeded in maintaining the practical nature of the work, and in their attempt to keep abreast of modern teaching and practice they have shown great discretion in their choice of new material. One of the most valuable chapters is that dealing with nitrous-oxide anæsthesia, with its lucid description of the technique of administration.

Where only limited space is available care has been taken that details essential to safety shall not be omitted, a good example occurring in the case of ether-oil anæsthesia, where the advice is given to be content with a 50 per cent instead of a 75 per cent solution, and an incomplete rectal, supplemented by slight inhalation, anæsthesia.

Mr. Wood, in re-editing the section on local analgesia, has dealt with his subject in the same clinical manner so characteristic of the whole of this attractive little book.

The Pressure Pulses in the Cardiovascular System. By C. J. WIGGERS, M.D., Professor of Physiology in the School of Medicine of Western Reserve University, Cleveland, Ohio. Demy 8vo. Pp. 200 + xi. Illustrated. 1928. London: Longmans, Green & Co. 14s. net.

THIS book, whose author is a well-known professor of physiology in America, is one of a series of monographs on physiology. It is concerned with the methods of measurement of the endocardiac pressure, and the interpretation of the records. The author's procedure is to insert a cannula into the ventricle through its wall, or into the auricle through a vein. The cannula is led off to a manometer with a rubber dam bearing a mirror, the movements of which are recorded by reflected light. Dogs are generally used, and artificial respiration is necessary. One outstanding result is the demonstration that the intraventricular pressure is never below zero. This probably accounts for the fact that we no longer stand in dread of serious trouble from air entering the heart through cut veins during an operation on the neck. The differences in type between the subclavian, radial, and femoral pulses in man are figured and discussed. The larger arteries are capable of undergoing local tonic contractions. The book may be warmly commended to those surgeons who retain an interest in the physiological problems of the heart even when the clinical application is not immediately obvious.

The Blood Plasma in Health and Disease. By J. W. PICKERING, D.Sc. Lond., Lecturer on Hæmatology, University of London, King's College. Monographs of Medical and Surgical Science. Demy 8vo. Pp. 247 + xi. 1928. London: William Heinemann (Medical Books) Ltd. 12s. 6d. net.

THIS book contains an excellent review of the modern work on coagulation of the blood and the diseases in which it is altered. The author, who has made this field his special study, has not only discussed the literature of the subject, including his own work, but has made many stimulating suggestions to point the way for further research. Points of clinical importance receive their due attention. The book is of value to physiologist, physician, and surgeon alike.

The Tonsils and Adenoids and their Diseases: Including the Part they play in Systemic Diseases. By IRWIN MOORE, M.B., C.M. (Edin.), late Honorary Surgeon to the London Throat Hospital and Metropolitan Hospital for Diseases of the Throat, Nose and Ear, Great Portland Street. Demy 8vo. Pp. 395+xix, illustrated. 1928. London: William Heinemann. 21s. net.

THE author has set himself the task of concentrating that which is of importance from the enormous mass of periodical literature relating to tonsils and their diseases. The appearance of such a work is timely, and, although Irwin Moore has himself in the past published a number of papers on the subject, he has succeeded in giving a reasoned statement without undue personal bias. The book is readable, and its value is much enhanced by the number of references to the literature which it contains. In addition to the details of operative technique, the anatomy and pathology of the tonsils are fully dealt with, while the chapter devoted to treatment in cases in which surgical removal is contra-indicated should be particularly useful. The nasopharyngeal and lingual tonsils have each a chapter devoted to themselves, and, under the former, the inclusion of a description of breathing exercises to be used after operation is both an unusual and acceptable feature.

EPOCH-MAKING BOOKS IN BRITISH SURGERY.

By SIR D'ARCY POWER, K.B.E., London.

X. HUNTER'S OPERATION FOR THE CURE OF ANEURYSM.

So obsessed have modern English surgeons become by the name of Lister that it would be difficult for many of them to say off-hand why Hunter is looked upon, by those who know, as the greatest of surgeons. He was a bad lecturer, a confused thinker, and a very indifferent writer, yet he found surgery mediæval and clinical; he left it a science. How was it done? Go to the museum he collected and let each one see for himself. Study it and the whole science of surgery is displayed in terms of morbid anatomy, comparative as well as human. Many surgeons before him had collected pathological specimens and made museums, but they had used them solely for teaching purposes and they had passed by sale from teacher to teacher. Hunter alone collected not to teach but to learn, and comparing like with like he thought about them and drew wholly fresh conclusions. A few of his contemporaries and the most receptive of his pupils entered into his spirit. To them he was 'the Dear Man'; they had penetrated his shyness and quarrelsomeness. and to them he was a personality ever urging them to follow out his lines of thought. He thus became the founder of a great school of scientific surgery which owed as much to his successors as to himself for its widepsread influence both at home and abroad.

Hunter's work was encyclopædic, for his curiosity was insatiable. We are concerned only with the surgical side, and it is difficult to make a selection. The treatise on inflammation, divested of its rugged style, contains much food for thought and foreshadows many of the surgical discoveries afterwards made possible by advances in chemistry and in physics. The essay on gunshot wounds, based upon only a short experience of actual war, taught that such wounds are not things apart, but should be treated on the same principles as govern other kinds of wounds. The pamphlet upon venereal diseases proved of value, although it was based upon incorrect

premisses and the conclusions were wrong ; yet it served its purpose because it led to a very thorough examination of the diseases by those who wished to refute the author.

It is interesting to follow up the line of procedure which Hunter adopted when he desired to unravel a new idea, and this can be done with tolerable ease in the case of his operation for the cure of popliteal aneurysm.

On May 22, 1788, Mr. Edward Ford, living in Golden Square and Surgeon to the Westminster Dispensary, which afterwards became the Westminster Hospital, communicated to the *London Medical Journal* a letter " On Cases of the Spontaneous Cure of Aneurism ". The first history was that of John Cathay, age 36, of Great St. Andrew's Street, Seven Dials, who had an aneurysm of the left popliteal artery which disappeared, though he died afterwards of a right femoral aneurysm. Hunter had seen the case during life as early as September, 1785. He attended the post-mortem examination, secured the specimen, and had it carefully drawn. The second history is that of a man in whom a large popliteal aneurysm was so far cured by prolonged rest that he could walk ten miles without harm. This case Hunter had also seen. Ford was opposed to operation, whether by amputating the limb or tying the artery, on the ground that it usually ended in the death of the patient. He pointed out that the cure by nature is permanent ; that the inert mass left behind is not likely to produce any mischief ; that the unsuccessful event of the operation for the popliteal aneurysm does not depend principally on any particular hazard in consequence of an obstructed circulation in the ham, but upon other causes ; and, most important of all, that if the communicating branches above the tumour are large enough to carry on the circulation in the extremity, the patient may recover, but if they are not, a mortification must of course ensue.

These conclusions were probably formulated after consultation with Hunter, who was living near by in Leicester Square. At any rate, after talking the matter over with Ford and carefully examining the piece of artery which had become converted into what would now be called fibrous tissue, he set to work experimentally. The story is continued by Everard Home in 1793 shortly before the death of his brother-in-law. He says : " Mr. Hunter finding an alteration of structure in the coats of the artery previous to its dilatation and that the artery immediately above the sac seldom unites when tied up in the operation for the aneurism, so that as soon as the ligature comes away, the secondary bleeding destroys the patient, was led to conclude that a previous disease took place in the coats of the artery in consequence of which it admitted of dilatation capable of producing aneurism. But not satisfied with the experiments on frogs, given by Haller in support of the opinion that weakness alone was sufficient to produce the dilatation, he resolved to try the result in a quadruped, which, from the vessels being very similar in their structure to those of the human subject, would be more likely to ascertain the truth or fallacy of Haller's opinion.

" Mr. Hunter laid bare the carotid artery of a dog for above an inch in length and having removed its external coat and afterwards dissected off the other coats layer by layer till what remained was so thin that the blood was plainly to be seen through it, left the dog to himself. In about three weeks

the dog was killed and the parts examined. when it appeared that the two sides of the wound having closed upon the artery. the whole of the surrounding parts were consolidated, forming a strong band of union, and the artery itself was neither increased nor diminished in size.

"This experiment appeared very conclusive, as the coats of the artery were weakened to a much greater degree without dilatation than can ever happen from accident in the living body, independent of morbid affection. But it was objected on the other hand, that the parts having been left to themselves, immediately closed upon the weakened portion of the artery, and, being cemented together by the coagulated blood, effectually secured it against any dilatation. To try the force of this objection, I [i.e., Everard Home] made the following experiment.

"I laid bare the femoral artery of a dog, about two inches below Poupart's ligament, for about an inch in length and dissected off the coats till the hæmorrhage from the vasa vasorum was considerable, and the circulating blood was distinctly seen through the internal membrane of the artery. The hæmorrhage soon stopped by exposure, the surface was wiped dry and afterwards covered with a dossil of lint to prevent the sides of the wound from uniting. The dog continued very well, and the wound healed up from the bottom; after six weeks the dog was killed and the artery was injected, that it might be examined with greater accuracy. It was not perceptibly enlarged or diminished and its coats at this part had recovered their natural thickness and appearance.

"The results of these experiments confirmed Mr. Hunter in his opinion that the artery, in cases of aneurism, is in a diseased state and led him to believe that the disease often extends along the artery for some way from the sac; and that the cause of failure in the common operation arises from tying a diseased artery, which is incapable of union in the time necessary for the separating of the ligature. The femoral and popliteal arteries are portions of the same trunk, presenting themselves on different sides of the thigh, and are readily come at in either situation; but where the artery is passing from the one side to the other, it is more buried in the surrounding parts and cannot be exposed without some difficulty.

"In performing the operation for the popliteal aneurism, especially when the tumour is large, the ligature is commonly applied on the artery at that part where it emerges from the muscles. This mode of performing the operation will be found inadequate if the disease of the artery extends above the sac; for if the artery should afterwards give way, there will not be a sufficient length of vessel remaining to allow of its being again secured in the ham. To follow the artery up through the insertion of the triceps muscle, to get a portion of it where it is sound, becomes a very disagreeable part of the operation; and to make an incision upon the fore part of the thigh, to get at and secure the femoral artery would be breaking new ground; a thing to be avoided, if possible, in all operations.

"Mr. Hunter, from having made these observations, was led to propose, that in this operation the artery should be taken up in the anterior part of the thigh, at some distance from the diseased part, so as to diminish the risk of hæmorrhage and admit of the artery being more readily secured should

any such accident happen. The force of the circulation being thus taken off the aneurismal sac, the progress of the disease would be stopped ; and he thought it probable, that if the parts were left to themselves, the sac with its contents, might be absorbed and the whole of the tumour removed which would render any opening into the sac unnecessary.

" Upon this principle Mr. Hunter performed the operation at St. George's Hospital."

The first operation was performed upon a coachman, age 45, in December, 1785, and the patient died on April 1, 1787. fifteen months after the operation. A post-mortem examination was obtained with difficulty and it was found that the aneurysmal sac had shrunk and was filled with laminated clot.

Hunter performed the operation five times and with sufficient success to show the correctness of his theory that : (1) Slowing of the blood-stream would cure an aneurysm ; (2) Aneurysm was caused by disease of the artery and was not the simple result of long-continued local injury ; (3) So long as there was sufficient collateral circulation gangrene would not result from ligature of the main artery—amputation therefore was unnecessary.

DERMOID CYST OF THE MEDIASTINUM.

By Sir CARRICK ROBERTSON,

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AND R. E. BEVAN BROWN,

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On consulting the literature we find records of 123 cases of mediastinal der-moids. This number is small when we consider that the condition is an arresting one and on this account more likely to be reported, and that this number comprises all the cases recorded over many years in Europe and America. Consequently we feel that the occurrence of such a case is worthy of mention.

CASE HISTORY.

The patient, Mrs. W., age 36, was admitted to the Auckland Hospital on June 11, 1928. She was described as having suffered as a child from a 'weak chest' ; at the age of 14 she contracted rheumatic fever, followed by chorea, which lasted
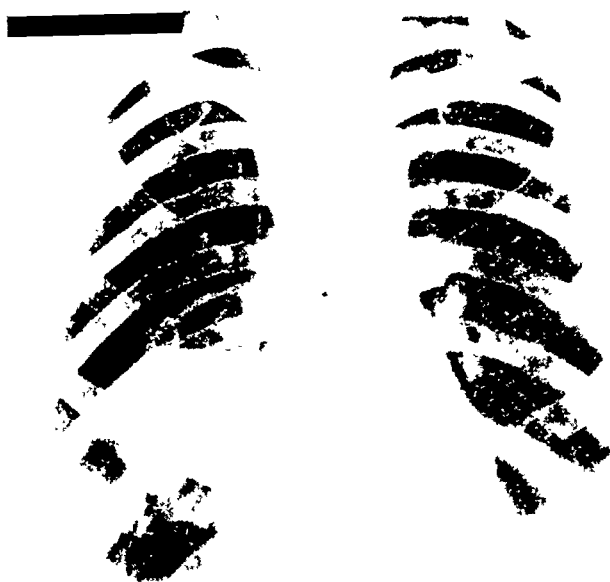
Fig. 129.—Antero-posterior radiogram of chest before operation.

several years, and she was more or less an invalid up to the age of 22. For the last ten years her menstrual history had been normal and healthy, but prior to that periods were scanty and irregular. Patient was a nullipara.

Three years prior to admission she began to have severe paroxysms of coughing, which came on every few weeks. No expectoration followed till eighteen months before admission, when she coughed up a hair. Since then she occasionally coughed up a few hairs during a paroxysm. Three months before admission after a severe bout of coughing she brought up a number of coarse white hairs about three inches long. After this on various occasions she coughed up hairs and sebaceous matter. A fortnight before admission she consulted Dr. Horton, St. Heliers, to whom we are indebted for much clinical information : she had a very severe attack of coughing, with pain in the back and below the right breast. The day before her temperature was 101°, and she was coughing up yellow granules and several hairs. There were no abnormal physical signs in the chest. Temperature fell to normal and the pain was relieved, but she continued to cough up sebaceous material.

FIG. 130.—Lateral radiogram of chest before operation.

Dr. F. J. Gwynne, radiologist, was consulted, and reported as follows (*Figs.* 129, 130): " In the anterior mediastinum, on the right of the midline, there is a rounded, well-defined, abnormal shadow. It extends between the second and fourth rib-cartilages and is about three inches in diameter. In the erect position the upper quarter containing air is separated from the lower part of the obscurity by a definite fluid level. The findings are consistent with the diagnosis of dermoid cyst of the mediastinum."

At the same time a sample of the sputum was submitted to one of us (R. E. B. B.). The specimen consisted of yellow sebaceous material and a few hairs. Microscopically it showed a few epithelial cells, and enormous numbers of bacteria. No pus cells were seen. Cultures grew *B. coli communis* and diphtheroid bacilli, suggesting a heavy infection but one of relatively low virulence. It was reported that all the evidence pointed to the presence of a dermoid cyst of the mediastinum, which had become infected.

Radiological, laboratory, and clinical findings left no room for doubt. The finding of hairs is regarded as conclusive (though
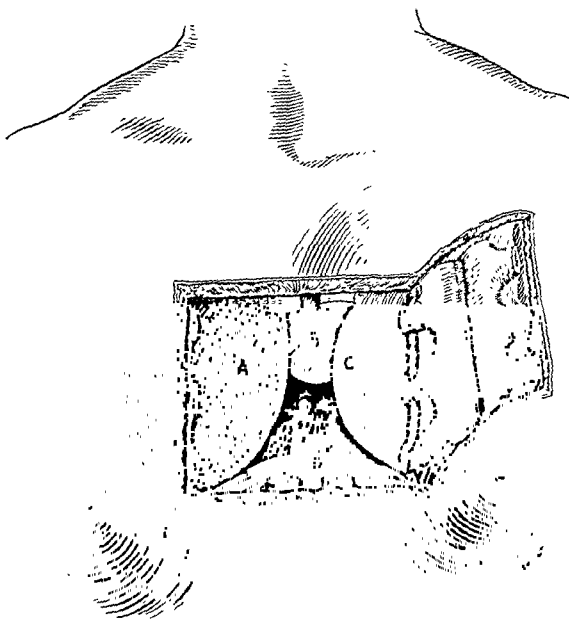
FIG. 131.—Semi-diagrammatic view of the tumour and its relations. Note the bifid sternum. A, Right lung ; B, Dermoid ; C, Pericardium ; D, Diaphragm.

apparently this is a rare occurrence, only eight previous cases of the kind being recorded). No other condition than that of a dermoid cyst rupturing into a bronchus could account for the facts. Radical surgical treatment was regarded as imperative, as, if left alone, the cyst might exert grave pressure symptoms on vital structures, and if through rupture its highly infected contents escaped into the mediastinum, fatal suppuration was almost certain to be the result. Consequently operative measures were decided upon, and carried out by one of us (C. R.) in two stages.

At the first stage (June 15), a trap-door consisting of the second, third, and fourth costal cartilages of the right side and the corresponding piece of the sternum was lifted up. The flap was made to hinge on the left side by dividing the left costal cartilages with a knife. Both the right and left internal mammary arteries were secured and tied. A hard-walled cyst was now felt, deeply placed in the mediastinum. The appearance and relations of the cyst can be seen in *Fig.* 131.

Unfortunately manipulation of the trap-door at this stage resulted in a perforation of the pleura on both sides. The patient immediately collapsed, as no

Fig. 132.—Antero-posterior radiogram of chest after operation.

air entered the trachea. Dr. Gould, the anæsthetist, promptly passed an intratracheal catheter and pumped in oxygen. In the meantime the flap was hurriedly scaled down to prevent further air from entering the pleural cavities. Gradual improvement took place, but largely owing to the unstable and excitable mental condition of the patient, convalescence was not a tranquil process for some days.

The second stage was performed on July 6. On this occasion Dr. Gould administered intratracheal ether from the beginning. The trap-door was lifted up, and the cyst was then seen as a whitish round mass, partly covered by and firmly adherent to the anterior border of the right lung. On the left side the pericardium over the right auricle was closely adherent, and covered this part of the cyst. The left innominate vein was adherent to the upper part of the cyst. A patient dissection was now carried out, and as there was no line of cleavage between the cyst and surrounding structures, progress was slow. Considerable difficulty was encountered :

the cyst wall was friable and broke away in many places; posteriorly the cyst extended well into the posterior mediastinum. Eventually it was all removed. No sign of the bronchial fistula was apparent. The cyst was about the size of a small coconut. A drainage tube was put into the depths of the wound and a suction apparatus attached thereto. A free discharge of blood-stained fluid continued for some hours, but the suction drainage removed it before it caused any untoward pressure symptoms. It is almost certain that the pericardium was opened in the region of the right auricle and that the right pleura was again perforated, but the suction apparatus, acting continuously, prevented the serous exudate from the large raw area flowing into these cavities. Our feeling was that the suction drainage was a great factor in the patient's recovery. Save for some superficial sepsis, which for some weeks delayed the healing of the wound, recovery was uneventful. The patient's temperature was normal from the sixth day. She was discharged on Aug. 16. On Oct. 9 she appeared before the Auckland Clinical Society. She was in excellent health, all the symptoms had disappeared, and she complained of nothing at all save occasional tachycardia. An X-ray photograph taken at this time (*Fig.* 132) shows a practically normal chest.

DISCUSSION.

There is a considerable literature relating to dermoid cysts of the mediastinum.

Age Incidence.—If we take the age at the time of operation or death as the age of incidence, cases commonly occur between the ages of 15 and 35, i.e., mainly in young adult life. Usually, however, there have been vague symptoms pointing to a much longer history—to puberty or much earlier. As there is an embryological explanation of their occurrence one might expect symptoms from birth, but of course the cyst may not start to grow till much later—e.g., at puberty. For all that, dermoid cysts and teratomata of the mediastinum have been noted in infants. The history of 'weak chest' during childhood in the case of our patient points to a similarly early origin.

Symptoms and Signs.—There is general agreement that symptoms and signs may be variable or slight. The onset may be insidious, and in a number of recorded cases no tumour was suspected before autopsy. Where symptoms and signs are present they are usually related to the respiratory system; cough, dyspnœa, and free expectoration are relatively common. Hæmoptysis occurs in a few cases. The coughing up of sebaceous material, through rupture into a bronchus, is sometimes seen : more rarely hairs are coughed up at the same time, which is diagnostic. Christian mentions one case of dysphagia.

Pain (felt locally) is relatively rare, and venous engorgement of the neck due to intrathoracic pressure still more so. In one or two cases a visible tumour has appeared above the sternum. Febrile symptoms and general malaise may of course occur. Commonly the diagnosis is made of some pulmonary or pleural disease—e.g., encysted empyema, pulmonary tuberculosis, bronchiectasis, or tuberculosis of mediastinal glands ; sometimes the tumour is thought to be an aneurysm of the aortic arch or an hydatid cyst of the lung. It is said that X-ray appearances are characteristic, and such is our experience in this case.

Course.—The general opinion seems to be that most patients succumb in one to four years from the onset of symptoms unless surgical intervention takes place. We have already referred to the dangers of neglecting the

condition; the cyst may increase in size, and the effects of its pressure on the heart, great vessels, lungs, trachea, or other structures may be serious. If rupture into a bronchus takes place, infection is almost bound to ensue, and such infection involves the grave risk of a mediastinitis. Some writers declare the cyst may become malignant. We do not know how to assess this danger; it may be that such malignant tumours were malignant in the first instance, but we cannot dismiss the danger until we know more. Death may occur sometimes independently or from intercurrent infection.

Treatment.—There is general agreement that complete excision is the only satisfactory method of treatment; but where dense adhesions to vital structures exist such a procedure may be impracticable.

The following is Beye's summary of figures relating to 57 cases operated upon (out of 119 recorded cases) :—

REPORTED CASES	NUMBER OF OPERATIONS (COMPLETE EXCISION OR DRAINAGE)	RECOVERED	IMPROVED	FURTHER HISTORY UNKNOWN	DIED
119	57	22	17	5	12

As these figures include many cases in which complete excision was not attempted, the results cannot be regarded as very unfavourable considering the difficulties of the anatomical situation.

Aurousseau, in an analysis of 38 operations (85 cases), shows the following figures :—

TOTAL NUMBER OF CASES	TOTAL OF OPERATIONS	INCISION AND DRAINAGE	INCOMPLETE EXCISION	COMPLETE EXCISION	CURED	SEQUELÆ	DIED	FURTHER HISTORY UNKNOWN
85	38	—	—	—	19	5	11	3
—	—	21	—	—	3	5	10	3
—	—	—	4	—	4	—	—	—
—	—	—	—	13	12	—	1	—

From this it will be seen that with simple incision and drainage a heavy mortality risk is incurred. The risk is much reduced in the case of complete excision; in the case of incomplete excision the figures are too small to warrant any deductions.

Since Beye's article we can trace 5 more cases, including our own. In 4 of these the tumour was successfully removed. In the fifth case, reported by Poynton and Moncrieff, the patient was an infant, and operative measures were impracticable; a very large teratomatous cyst was found at autopsy.

Pathology, etc.—The origin of these cysts is mostly connected with the branchial arches, and is therefore concerned with the fœtal period of life. Beye quotes an apposite statement by Ewing: " The intimate relations of the ectodermal and entodermal layers of the third and fourth arches may explain the variety of epithelium and the connection with the thyroid and thymus,

while the descent of the heart may carry these structures deep into the thorax. Dermoids of the lower mediastinum may result from imperfect closure of the anterior chest wall." Regarding the latter point, Bland-Sutton suggests that they arise from some fault in the median coalescence of the sternum ; failure of this kind was noted in our patient, whose sternum was bifid throughout its whole length (*see Fig.* 131).

Ewing divides these tumours into simple dermoids and teratoid tumours. The simple dermoids show epidermal lining with dermal glands, and contain sebaceous material and hair. Teeth may be present. The tumours may be unilocular or multilocular cysts. That is to say, simple dermoids arise from ectoderm ; mesodermal and endodermal layers are not represented. " The complex tumours are tridermal, and contain. besides epidermis, bone, cartilage, nervous tissue, intestinal tract, respiratory ciliated epithelium, and thyroid " (Ewing). The same author quotes Ekehorn as pointing out that " the great majority of mediastinal dermoids prove to be tridermal teratomas."

Histological examination of the cyst wall in our case showed an inner lining of squamous epithelium, which in one situation gave place to an exuberant growth of columnar epithelium. Sweat and sebaceous glands, as well as hair follicles, were seen in the subjacent fibrous stroma, as well as some small cysts. There was only scanty evidence of an inflammatory reaction, which is in keeping with the saprophytic nature of the infection present. As the histological findings did not show any mesodermal structures—c.g., muscle and cartilage—the tumour must in our opinion be classed as a dermoid cyst, rather than a tridermal teratoma, in spite of the occurrence of columnar epithelium.

Thus up to date there are records of 124 cases of this condition, and so far as we have been able to ascertain ours is the ninth case where a history of coughing up of hairs has been obtained.

We are indebted to Dr. F. J. Gwynne, of the Radiology Department of the Auckland Hospital, for supplying us with X-ray photographs and his comments thereon.

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CHOLESTEROSIS OF THE GALL-BLADDER:

A CLINICAL AND EXPERIMENTAL STUDY.*

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THE lesions characterized by infiltration of the gall-bladder with cholesterol have occasioned considerable interest since, twenty years ago, the 'strawberry' gall-bladder was first described, and their importance surgically has received increasing recognition.

There are two types of cholesterosis. Of these the better known is the 'strawberry' change, in which the infiltration is widespread. Less common is the type in which localized deposits of cholesterol occur in small polypoidal projections of mucous membrane—'cholesterol polypi'. These types appear to have no essential distinction (the difference of appearance being simply due to the massive localization of cholesterol in the second type, leading to prominence and pedunculation of the mucosa), and it is common to find the two types associated.

It is perhaps not generally recognized that cholesterosis of the gall-bladder, far from being a rare lesion, is actually very common. By the courtesy of Professor Wilkie, the writer has had the opportunity of studying 35 cases, of which 21 have been found during the past year, and it is therefore felt that the time is ripe for a survey of all aspects of the disease, clinical and pathological, and for a report upon experimental work which has been carried out in regard to its pathogenesis.

HISTORICAL.

Although the occurrence of cholesterol in the gall-bladder wall appears to have been recognized a long time previously,[1] the macroscopic picture of cholesterosis escaped the attention of surgeons and pathologists alike until as late as 1909—a fact the more remarkable when it is realized that this condition, far from being rare, is found with considerable frequency both at operation and in the post-mortem room, and is, moreover, of very striking appearance unless obscured by discoloration with bile.

The first description of the naked-eye appearance of cholesterosis we owe to Moynihan,[2] who described and illustrated very beautifully three cases in which the condition was found. At that time it was regarded as being due to innumerable small stones embedded in the mucosa, and it was not until several years later that its true significance was recognized.

MacCarty[3] in the following year described further cases (attributing the appearance to an erosion of the mucous membrane with a secondary bile-staining and fibrosis), and gave the descriptive name of 'strawberry' by which the condition is generally known.   More recently Mentzer[4] has applied the term cholesterosis to include all degrees of the disease.

Much of our knowledge of cholesterosis we owe to Boyd,[5] whose masterly paper was published in 1923.   In particular, Boyd described in very lucid terms the naked-eye and microscopic appearances, and gave convincing proof of the nature of the lipoid involved in the infiltration.

In recent years the frequency of cholesterosis has led to a somewhat greater interest, especially among French workers, but even yet its importance has not gained widespread recognition.

NAKED-EYE APPEARANCE.

Diffuse Cholesterosis (Strawberry Change).—In a well-marked example of the 'strawberry' gall-bladder the appearance is striking in the extreme (*Figs.* 133–135). The mucous membrane of the whole organ is usually congested and deep red, and scattered over it are innumerable tiny nodular specks of bright-yellow hue, the whole appearance closely resembling that of a ripe strawberry.

The appearance is even more striking, as Boyd has pointed out, if the gall-bladder is examined under a binocular dissecting microscope.   In the healthy organ the surface of the mucosa is seen raised up into numerous tall, thin, gossamer-like ridges (which, from their appearance in cross-section are known, incorrectly, as villi) surrounding deep oval or polygonal hollows. In the 'strawberry' gall-bladder these ridges, instead of being thin and tenuous, are stout and swollen, and within them the lipoid is seen as dense or streaky masses, which, in the words of Boyd, load the villi "much as the delicate birch tree might be weighed down by a load of snow."

The lipoid is for the most part confined to the prominences of the ridges, though in rare cases it may also invade the deeper recesses of the wall.   In severe examples practically the whole extent of the summits of the ridges is occupied by the deposits, and they then appear as yellow linear streaks running chiefly in a longitudinal direction.

FIG. 133.—'Strawberry' gall-bladder. In the congested mucous membrane are many tiny yellow deposits of cholesterol. One larger polypus is also present. (*D. P. D. Wilkie's case.*)

In other cases the lipoid is deposited, not in streaks, but in pin-head nodules within the villi.

The distribution of the lipoid may be widespread, affecting all the ridges throughout the gall-bladder, but is more frequently patchy. Certain portions seem particularly apt to be affected, and in early cases it is not infre-

FIG. 134.—'Strawberry' gall-bladder. The cholesterol infiltration of the mucous membrane is well marked and extends over the whole of the gall-bladder. (*Sir H. Stiles's case.*)

quent to find a limited area of cholesterosis at about the mid-point of the gall-bladder or towards the neck, and the rest of the organ may appear healthy. Less commonly the lesion may be found only at the fundus.

A curious and important observation is that, when the lipoid

deposits are traced along the ridges towards the ductal end of the gall-bladder, they are found, even in the most marked examples, to end abruptly at a point which in some specimens corresponds to the commencement of the cystic duct; while in others it is placed a little

FIG. 135.—The same case as in *Fig. 134*. The ridges of mucous membrane are projecting, distended with lipoid, of pale yellow colour.

closer to the fundus than this point. It is often found that the infiltrated ridges, which for the most part are arranged longitudinally, merge together at this point into a transverse yellow line; beyond this the mucosa appears perfectly free from lipoid.

or at the most there may be one or two tiny seedlets in an otherwise normal membrane.

Cholesterol Polypi.—Here the lipoid, instead of being scattered diffusely over the gall-bladder wall, is aggregated into larger masses in one, two, or more sites. The villus in which it is deposited becomes progressively swollen and polypoid, and eventually may become a large pedunculated mass attached to the wall by the finest of filamentous stalks (*Fig.* 136). The surface of such a mass may be undulating, gyrate, or lobulated. Its colour, when small, is a bright yellow. Later, as increase in size continues, deposition of bile pigments may give it a greenish or brownish hue. In some cases the polypus consists almost entirely of lipoid material, with a thin epithelial covering which may in part be absent ; in others the polypus has a fleshy appearance, with relatively little lipoid. Such polypi may occur singly, or as many as ten or twelve may be present. Not infrequently, in addition, some degree of 'diffuse' cholesterosis is also found.

Associated Disease of the Gall-bladder. — Cholesterosis may occur either alone or in association with various degrees of inflammation. Occasionally it appears to be a definite pathological entity in a gall-bladder which presents no evidence of any morbid change apart from the cholesterol deposits in its wall. To the naked eye the gall-bladder appears of normal blue colour, quite unthickened, and so transparent that the deposits of cholesterol may be visible from the peritoneal aspect before the gall-bladder is opened ; and even on careful histological examination no trace of an inflammatory process is visible. Such cases are, however, uncommon, at least in the examples seen at operation, and only one has been encountered in this series. The majority of cases are associated with some degree of cholecystitis. This may be well marked, the gall-bladder being thickened with old fibrous tissue, but is most characteristically of mild degree. The most common type of gall-bladder to be affected is that which at operation appears just slightly thickened, with some excess of subserous fat and a mild pallor and opacity which mars the healthy blue colour.

Grosser inflammatory disease of the gall-bladder is less common, and this, even when marked, is usually found to be confined principally to the outer

Fig. 136.—Solitary cholesterol polypus, of large size, attached to the subjacent mucous membrane by a delicate stalk.

coats, the mucosa being relatively intact. Cholesterosis never occurs in the presence of extensive scarring or atrophy of the mucous membrane, and is never found as a manifestation of acute cholecystitis (though, of course, an acute inflammation may supervene in a gall-bladder which already contains cholesterol deposits).

Cholesterosis may also, rarely, be associated with malignant disease of the gall-bladder.[5] Gall-stones may be present or absent.

The association of cholesterosis with mild rather than severe cholecystitis has been noted especially by Boyd, who found that in one case, where only part of the wall was infiltrated with cholesterol, the remaining parts showed more profound inflammatory change. He concluded from this that the lipoid deposition was an early phenomenon in the disease process and might disappear as the disease advanced.

Table I illustrates the relation of cholesterosis to cholecystitis in the 35 cases of this series. It will be seen that in 11 gall-bladders showing generalized 'strawberry' change, 1 showed no trace of inflammation either to the naked eye or histologically, 1 was only proved to be mildly inflamed by microscopic examination, and 3 others had a very mild degree of chronic cholecystitis.

Similarly, in 10 cases out of 20 gall-bladders with patchy 'strawberry' cholesterosis, the associated inflammatory change was meagre, and the same was true for all the 4 cases in which polypi alone were found.

In general, the gall-bladders containing stones were considerably more thick-walled than the others, and if these cases are excluded the preponderance of mild inflammatory changes is still further increased, for moderate or gross chronic cholecystitis occurred in only 4 of the 18 cases without stones.

Table I.—RELATION OF CHOLESTEROSIS TO CHOLECYSTITIS.

TYPE OF CHOLESTEROSIS	No. OF CASES	GRADE OF CHRONIC CHOLECYSTITIS					
		None	Recognized only microscopically	Slight opacity of wall	Wall moderately thickened	Wall grossly thickened	Acute exacerbation
* Generalized 'strawberry'	11	1	1	3	4	1	1
† Patchy 'strawberry'	20	0	1	9	3	6	1
Polypi alone	4	0	2	2	0	0	0
TOTAL	35	1	4	14	7	7	2
Total cases with stones	17	0	0	5	4	6	2
Total cases without stones	18	1	4	9	3	1	0

* One of these also contained polypi. † Four of these also contained polypi.

Occurrence of Gall-stones with Cholesterosis.—Gall-stones have been present in nearly half of the cases in this series, namely in 17 of the 35 cases of cholesterosis.

It is of particular interest to note that in the majority of these cases the stones have been composed of pure or almost pure cholesterol, either single stones (cholesterol 'solitaires') or multiple (of 'mulberry' type), and a relationship between the deposit of cholesterol in the mucous membrane and the formation of cholesterol stones seems clearly demonstrated.

MICROSCOPIC APPEARANCE.

General Histological Characters.—It has already been stated that cholesterosis may be associated with divers changes in the gall-bladder wall, and the histological appearance is therefore equally varied. There may be an extensive fibrosis of the deeper parts of the wall, or a less chronic lesion with engorgement of the vessels and some round-celled infiltration, or, on the other hand, the gall-bladder may show no deviation from the normal except for the deposit of lipoids.

In the majority of cases, however, certain characteristic features will be noted. However marked and old-standing the inflammatory changes, they
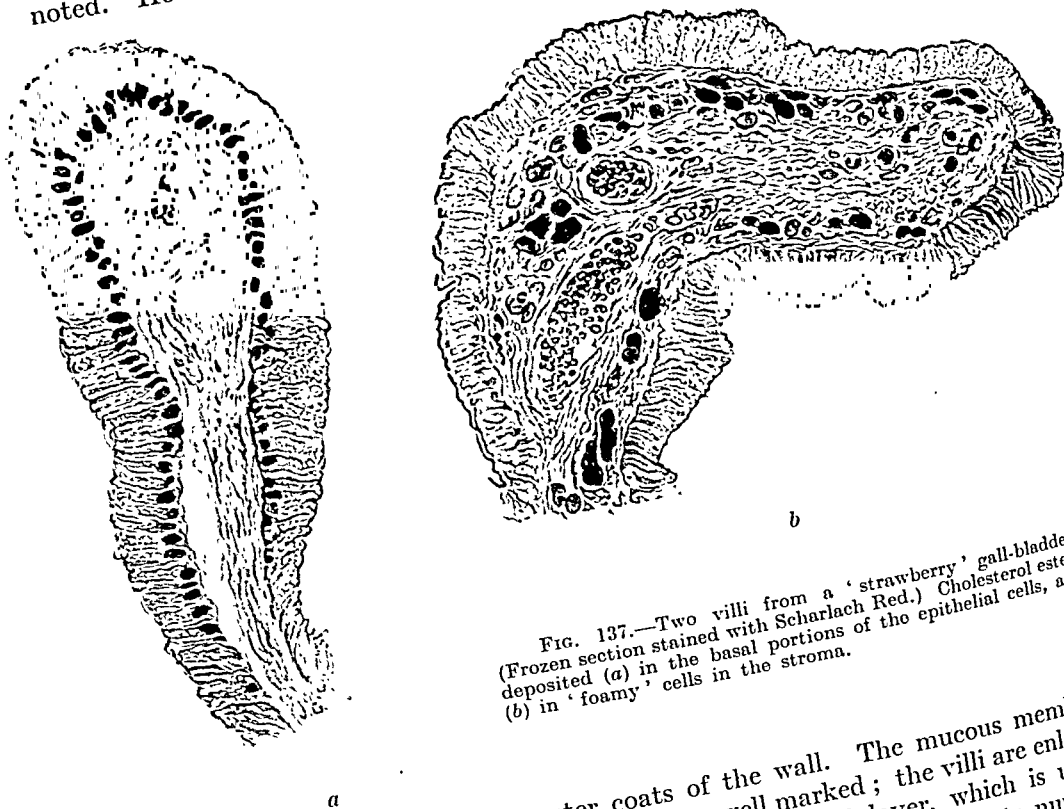
FIG. 137.—Two villi from a 'strawberry' gall-bladder. (Frozen section stained with Scharlach Red.) Cholesterol esters deposited (a) in the basal portions of the epithelial cells, and (b) in 'foamy' cells in the stroma.

are mainly confined to the outer coats of the wall. The mucous membrane usually shows some hyperplasia, sometimes well marked; the villi are enlarged, elongated, and almost pedunculated. The epithelial layer, which is usually complete unless eroded by pressure of stones, may be thrown into numerous

folds which, in sections, sometimes give a false impression of glandular acini. The stroma of the mucous membrane also shares in the hyperplasia. The connective-tissue cells are proliferated, and in addition there is often a mild degree of infiltration with leucocytes. Giant cells of the 'foreign body' type, which occur around many cholesterol deposits, are never seen in the 'strawberry' gall-bladder. A characteristic feature in the stroma is the vascular dilatation, which may be well marked.

Situation of the Lipoid.—The main mass of the lipoid is deposited in the mucous coat, though occasionally in advanced cases traces may also be visible in the fibromuscular layer. In the mucosa the deposits may be either in the epithelium or in the stroma. In some specimens the whole of the lipoid is in the one situation, in others it is in both ; sometimes in the same gall-bladder one portion of the section shows the epithelial deposit, another that in the stroma (*Fig.* 137). Moreover, different portions of the epithelial cells or of the stroma may be affected in different cases, giving rise to variations of appearance which are not readily explicable.

In the Epithelial Cells the most characteristic infiltration of lipoid is at the bases of the cells, in the form of large fatty globules which stain a bright red with Scharlach R. (*Fig.* 137 *a*). These globules are usually localized to the tips of the villi, but in marked cases they may extend to the intervening depressions, forming a sort of scarlet border to the whole section. In this basal situation the lipoid consists mainly of esters of cholesterol.

Less commonly the superficial part of the epithelial cells contains lipoid deposits, in the form of multiple fine granules, which contain little or no cholesterol and appear to consist of unsaturated fatty acids (*Fig.* 138).

In the Stroma of the Mucous Membrane the lipoid occurs characteristically in large amount. Though extracellular deposits have been described, these must be rare, and in all the cases of this

FIG. 138.—Section of 'strawberry' gall-bladder (stained osmic acid). Note the large grey 'foamy' cells (containing lipoid) in the stroma, and the dense black lipoid in the epithelium.

series the lipoid has been situated inside cells of various types.

The most important lipoid-containing cell is one which, from its appearance in paraffin sections, has been called 'foamy' (*Fig.* 138). It is a large mononuclear endothelial cell with a small, dark-stained nucleus and a very delicate reticular protoplasm, in the meshes of which are contained numerous minute droplets of cholesterol esters. Such foamy cells occur at first near the tips of the villi as small rosettes or in linear arrangement (*Fig.* 137 *b*). Later they may collect in large numbers, distending the villi to resemble air

FIG. 139.—Paraffin section from 'strawberry' gall-bladder (stained hæmatoxylin and eosin). The villi of the mucous membrane are swollen by numerous foamy lipoid-containing cells. These are seen as pale areas, from which the lipoids have been dissolved during preparation of the section. (× 100.)

balloons (Fig. 139) and penetrating down into the deeper parts of the stroma (Fig. 140). It is to the mass of lipoid in these foamy cells that the yellow colour of the 'strawberry' gall-bladder is mainly due.

Lipoid may also be found as minute droplets in small elongated or polygonal cells of the stroma, and, less commonly, it may occur in the endothelial cells of blood-vessels. In these two situations it contains no cholesterol.

The occurrence of lipoid has been noted in the lumen of blood-vessels, though this must be a rare phenomenon. Boyd described one case, in which complete proof was lacking, and Bergeret and Dumont[6] have described another. In this latter case actual foamy cells were seen in the lumen of a venule.

FIG. 140.—Frozen section from a 'strawberry' gall-bladder (stained with Scharlach Red). Note the dense masses of cholesterol distending the two villi. (× 50.)

NATURE OF THE LIPOIDS.

Boyd has described with great lucidity the methods in use for the recognition of lipoids, and they require but a brief outline here. It will be recalled that cholesterol and its esters can be most readily distinguished by their property of rotating the plane of polarized light, a property not possessed by other lipoids commonly occurring in the body. Cholesterol can be distinguished from its esters by various staining reactions, and, more exactly, by their melting points, that of pure cholesterol being 148° to 150° C. as compared with 37° to 42° C. for the oleate. Under the polarizing microscope a section of a 'strawberry' gall-bladder presents a brilliant appearance, large masses of anisotropic lipoid standing out in illumination against the dark background of the rest of the tissue. An interesting phenomenon is observed if the section is heated to approximately 40° C. At this point the lipoid masses disappear and their place is taken by numerous large and small 'Maltese crosses' of brilliant white colour, an appearance characteristic of the 'fluid crystalline state' in which the lipoid is physically fluid yet retains the optical properties of the solid.

Boyd has shown that much of the lipoid of the 'strawberry' gall-bladder responds to the tests for esters of cholesterol,* but it must be remarked that this applies only to the lipoid in certain situations (in the 'foamy' cells and in the base of the epithelium). In other parts of the mucosa non-cholesterol lipoid is found, which responds to the tests for unsaturated fatty acids. Thus it is seen that the 'strawberry' gall-bladder is really an infiltration with many complex lipoids, of which combinations of cholesterol and fatty acids are merely one manifestation, though no doubt the most important.†

BACTERIOLOGY.

Whenever possible cultures in Rosenow's brain-glucose-broth medium, or in ordinary glucose broth, have been taken from the gall-bladder wall, the bile, and the cystic lymphatic gland, and in a few cases also from the stones present. In the great majority of cases these tissues have proved sterile, and in the rest no characteristic flora has been found (*Table II*).

Table II.—BACTERIOLOGY OF CHOLESTEROSIS.

Tissue	No. of Cases	Sterile	Infected	Streptococci	B. Coli	Other Organisms
Gall-bladder wall	22	16	6	3	2	1
Bile	23	19	4	2	1	1
Cystic gland	21	19	2	1	0	1
Stone	3	2	1	1	0	0

* Strictly speaking, the tests mentioned apply to mixtures or loose combinations of cholesterol and fatty acids as well as to true esters, and it is probable that in cholesterosis various such mixtures occur. For the sake of simplicity they are here referred to as true esters.

† Since the completion of this paper a case has been observed of a well-marked 'strawberry' gall-bladder in which large masses of lipoid filled the epithelial cells and traces occurred in the stroma. In neither situation was any trace of doubly refractile cholesterol present, all the fat giving the reactions for fatty acids.

CHARACTER OF THE BILE IN CHOLESTEROSIS.

As Moynihan noted in his original paper, the bile is frequently dark, tarry, and extremely concentrated. This is especially the case where the cholesterosis is well marked (Table III), and of the 7 gall-bladders with general-ized 'strawberry' change in which the concentration of the bile was noted, all contained tarry bile. Apart from being highly concentrated, however, the bile is quite clear, and it is unusual to find any trace of turbidity.

Table III.—CHARACTER OF THE BILE IN CHOLESTEROSIS.

CHOLESTEROSIS	No. of Cases	CLEAR BILE		Tarry, with cholesterol flakes	Turbid bile
		Dilute	Tarry		
Generalized 'strawberry'	7	0	6	1	0
Patchy 'strawberry'	15	6	7	0	2
Polypi	2	0	2	0	0

It is true that the condition of the bile in a patient prepared for operation does not accurately represent that usually present, for in the fasting individual rapid concentration takes place; but comparing the bile with that of other patients similarly treated there seems no doubt that undue concentration is the rule.

The Cholesterol Content of the Bile, like its concentration, appears to be increased in cholesterosis. Table IV shows the readings obtained in six cases of this series. It will be seen that there is a very definite increase in the content as compared with the controls, especially where the cholesterosis is marked in extent.

Table IV.—CHOLESTEROL CONTENT OF GALL-BLADDER BILE.

GALL-BLADDER	Cases	Cholesterol Content	Averages
		Mgrm. per cent	
Patchy 'strawberry'	1	466	503·6
	2	445	
	3	600	
Generalized 'strawberry'	1	636	969·6
	2	1033	
	3	1240	
Controls (no cholesterosis)	1	156	329·3
	2	290	
	3	542	

These observations are of interest from two points of view: (1) The high index may account for the frequent presence of stones of pure cholesterol, the result of precipitation from the bile; (2) As will be considered later, a high cholesterol content may be important as one of the factors leading to cholesterosis.

CLINICAL FEATURES OF CHOLESTEROSIS.

ETIOLOGY.

If surgically removed gall-bladders are carefully examined in the fresh state, a degree of cholesterosis visible to the naked eye is found in a considerable proportion of cases, and well-marked typical 'strawberry' change is by no means rare. In 100 consecutive cholecystectomies during the past twelve months cholesterosis in some form was present in 21, a frequency corresponding fairly closely with that of other observers. In a larger collection of 35 cases of all types of cholesterosis, the well-marked 'strawberry' type was present in 11, and the patchy 'strawberry' type in 20. Cholesterol polypi occurred. alone in 4 cases, and were also present in 5 of those showing the 'strawberry' change.

Sex.—Cholesterosis appears to affect the sexes equally. In the present series men were affected in 4 (or 20 per cent) of 20 consecutive cholecystectomies; women in 17 (or 21·25 per cent) of 80. These figures, being based upon surgical cases in which women preponderate, do not necessarily represent the total incidence in the two series, but it is interesting to note that in a large autopsy series reported by Mentzer[4] a similar close ratio was noted.

Age.—Cholesterosis is a condition chiefly of middle life, though it has been found at the early age of 13. Mentzer states that the average age is 35. In this series the youngest patient was aged 28, the eldest 60, and the great majority exceeded 45 years.

Social State.—Remarkable similarity has been noted in the incidence of the disease in hospital and in private cases. Cholesterosis occurred in 12 (or 21 per cent) of 57 consecutive cholecystectomies in hospital, as compared with 9 (or 20·9 per cent) of 43 private cases.

ASSOCIATED LESIONS IN OTHER ORGANS.

Excluding cholecystitis and gall-stones, cholesterosis seems to have no relationship with other intra-abdominal disease. In 35 cases duodenal ulcer co-existed twice, hydronephrosis once, and pronounced visceroptosis once. Appendicectomy was performed in a considerable number of cases, but usually as a routine measure, and gross chronic appendicitis was present in only 2 cases.

SYMPTOMATOLOGY.

The symptoms presented by patients with cholesterosis of the gall-bladder are extremely varied, and even where other conditions such as gall-stones or marked cholecystitis are absent, the symptoms may be either very severe or entirely lacking.

Other workers have remarked that in cholesterosis the symptoms may be of some severity. Thus, Chiray and Pavel[8] state that the condition is a painful one, sometimes extremely so, and they describe cases in which the predominating feature was that of severe colicky pains recurring at frequent intervals. Fever, they state, is rarely absent at some stage of the disease, and icterus may be observed.

A history of this type has been obtained in four cases of uncomplicated cholesterosis in this series, with the exception that none of them has given

evidence of attacks of fever. All of them had suffered from attacks of pain, which appears to have been intense. One patient volunteered that the pain was worse than that of childbirth, and another stated that it made her roll about and perspire freely. The pain in all these cases closely resembled that of biliary colic, striking the patient in the right hypochondriac region and radiating to the scapula or to one or other shoulder, and necessitating the administration of morphia. In two cases the pain was followed by definite jaundice of several days' duration. In the intervals between the attacks these patients suffered from symptoms like those of chronic cholecystitis, aching pain in the hypochondrium, soreness of the skin in this region, flatu-·lence, and abdominal distension.

In spite of these clearly defined histories of severe symptoms, the gall-bladders in these four cases showed extremely little change except for the presence of gross deposits of cholesterol. No stones were present, and the degree of cholecystitis was very limited. In one case there was absolutely no histological trace of an inflammatory lesion; in a second such evidence was only obtained on microscopic examination, and in the remaining two the cholecystitis was of a very mild degree. Yet in all four cases the absence of any other gross intra-abdominal lesion and the curative effect of cholecystectomy prove that the symptoms had originated in the biliary condition.

The following is a typical case of this group :—

Case 2829.—Mrs. T., age 34, multiparous.
HISTORY.—During the two years previous to admission the patient had had pain on the right side of the abdomen. At first it came in attacks of great severity, which doubled her up and were ' worse than labour pains '. The pain was felt just below the right costal margin and passed to the back below the right scapula. She often had also a pain in the right shoulder. Most of the attacks came on during the day. They might last for a few hours and then pass off, or might recur at intervals over a few days. The pain came is spasms.
Ever since the attacks commenced she had complained of a soreness in the right side, which prevented her wearing tight clothing. She had occasionally been a little yellow-coloured, but definite jaundice had not been noticed. She had no indigestion and could eat any kind of food. Food never relieved the pain. Vomiting occurred when the pain was severe.
OPERATION.—Stomach, duodenum, common duct, and other viscera appeared healthy. The gall-bladder was for the most part of healthy appearance, but seemed a little pale and opaque at the fundus. It was removed. It contained thick, tarry bile, and no stones. The mucosa had the typical appearance of a 'strawberry' gall-bladder, with deposits of cholesterol in linear streaks over a somewhat congested mucous membrane. The wall of the gall-bladder was only very little thickened, and microscopic examination revealed only mild cholecystitis.
PROGRESS.—Reported nine months later : no recurrence of symptoms and is now well and symptom-free.

Such cases with severe symptoms are, however, rare, and the majority of patients give merely a history indicative of chronic cholecystitis—that is to say, the deposit of cholesterol does not appear to aggravate the symptoms due to the accompanying inflammatory change.

In others, again, the disease may be completely symptomless. Such was the case in a patient, age 31, whose only symptoms were those of stiffness in the hip-joint and pains in this region. No signs of local disease of the joint could be found, and as routine examination revealed slight tenderness over

the gall-bladder, this organ was removed as a probable focus of infection—a procedure which resulted in complete disappearance of the pain and joint stiffness. The gall-bladder proved to have a definite, though mild, degree of inflammation, and showed well-marked 'strawberry' change.

CLINICAL SIGNS.

These give little help in the diagnosis of cholesterosis. The general appearance of the patient is in no way dissimilar from that usually associated with cholecystitis, and the patients are usually, but not invariably, well nourished or stout. Local signs are merely those of chronic cholecystitis.

SPECIAL EXAMINATIONS.

Cholecystography.—The appearance of the cholecystogram depends upon the degree of accompanying cholecystitis or upon the presence of stones. If moderate cholecystitis coexists or stones are present, obscurity or absence of the cholecystographic shadow will result ; but, on the other hand, if cholesterosis is accompanied by little inflammatory change, the cholecystographic examination will show no deviation from the normal. Thus, in 8 cases of this series in which deposition of cholesterol was the main change visible to the naked eye, the administration of sodium tetraiodophenolphthalein invariably resulted in a dense 'normal' shadow of the gall-bladder, which, moreover, diminished markedly in size following a fat meal.

This examination (which incidentally indicates that cholesterosis *per se* does not interfere either with the concentrating function of the gall-bladder or with its contractility) is therefore only of value in the diagnosis of cholesterosis in that it may exclude the grosser diseases of the gall-bladder.

Blood-cholesterol Examination. — The cholesterol content of the blood has such a wide 'normal' range of values, and is subject to abnormal increase from such varied pathological or even physiological conditions (e.g., diabetes, parenchymatous nephritis, xanthoma, pregnancy), that the value of this estimation as a diagnostic measure must be limited. The recorded cases of cholesterosis in which blood-cholesterol estimations have been carried out are

Table V.—Blood-cholesterol Estimations.

GALL-BLADDER	NO. OF CASES	BLOOD-CHOLESTEROL			
		Low	Low normal	High normal	Raised index
Generalized 'strawberry'	6	0	2	1	3
Patchy 'strawberry'	3	0	1	2	0
Controls : Cholecystitis No cholesterosis	14	4	2	4	4

only two in number, but, in spite of this lack of concrete data, a state of hypercholesterolæmia has been presumed by many writers to be of constant occurrence in cholesterosis. It appears, however, that this is incorrect. In the present series estimations of the blood-cholesterol index have been carried out upon 9 cases of cholesterosis of all grades, and, as a control series, upon 14 cases

operated upon for lesions of the gall-bladder other than cholesterosis. Reference to *Table V* will show that an increased reading was almost as frequently obtained in the control series as in the cases with cholesterosis, and that exactly two-thirds of the latter cases were within the limits of normal. The blood-cholesterol estimation cannot therefore be regarded as of practical value in the diagnosis of cholesterosis.

DIAGNOSIS.

It will be obvious from the varied symptomatology that the diagnosis of cholesterosis must present great difficulties. On the one hand, severe pain simulating biliary colic and followed by transient jaundice will lead to the suspicion that a stone is present in the gall-bladder, and, on the other, the symptoms may be so trifling as to be missed.

In the majority of cases, however, the symptoms and signs point clearly to some lesion of the biliary tract, and the diagnosis of cholesterosis must depend either upon the exclusion of grosser lesions or upon special methods of examination. Of these, the one which seems to offer most assistance in the diagnosis is cholecystography.

It is now generally recognized that cholecystography, though by no means an infallible diagnostic measure, does give an indication either of gross chronic cholecystitis or of the presence of all stones except the smallest, and a 'normal' cholecystographic shadow excludes these conditions. In a patient with a clear biliary history and a 'normal' shadow the diagnosis is therefore narrowed down to one of the following lesions : mild chronic cholecystitis, cholesterosis, or small calculi. It must be admitted, however, that in the present state of our knowledge the diagnosis of this condition can only be tentative.

TREATMENT.

As cholesterosis is rarely recognized until an extirpated gall-bladder has been opened, consideration of the treatment is of academic rather than practical interest. In two circumstances, however, cholesterosis may be recognized at an earlier stage. The yellow deposits in the mucous membrane may be discovered when the gall-bladder is opened for the purpose of cholecystostomy, or occasionally they may be recognized in the course of an exploratory laparotomy, when they may be visible through the thin translucent gall-bladder wall.

In the former circumstances the indication for treatment seems clear. The gall-bladder having already been opened, only two courses are available— either drainage or extirpation. Drainage can have no therapeutic effect upon a disease localized to the wall of the gall-bladder, and is more likely to result in increased traumatization, infection, and scarring of the mucosa. Cholecystectomy is therefore clearly desirable.

The indication in the second circumstance, where cholesterosis is recognized in an untouched gall-bladder, is not so clear, and must be based upon our knowledge of the etiology of cholesterosis, and upon its symptoms and the possibility of spontaneous cure. In regard to this possibility little is at present known, and it is conceivable that in the absence of inflammatory lesions cholesterol deposits may eventually undergo absorption, with complete

restitution to the normal. The observations of Boyd and others, however, indicate that the disappearance of cholesterol is usually associated with an extension of the inflammatory process already present, and the treatment should therefore be directed towards the prevention of this. Medical measures are not known to have any influence upon lesions of the gall-bladder wall, and if symptoms are present which point to the biliary tract, in the absence of contra-indications the operation of cholecystectomy is called for. This treatment has been carried out in all the cases of this series, and, though the period since operation is in most instances too short to justify a final opinion, the results so far seem eminently satisfactory. In 6 cases of uncomplicated cholesterosis which can be traced, the period since operation has varied from six months up to four years These 6 cases include the 4 patients who gave histories of severe symptoms, and all six state that since the operation no recurrence of these symptoms has taken place.

PATHOGENESIS OF CHOLESTEROSIS.

INFILTRATION OR DEGENERATION ?

Throughout this paper cholesterosis of the gall-bladder has been referred to as an *infiltration*, and this description of its pathological significance requires some support. Can cholesterosis be classified as an infiltration of certain cells by cholesterol entering them from without, or may it be the result of a degeneration, i.e., an unmasking of cholesterol previously present in the cells combined in invisible form ?

The whole appearance of the 'strawberry' gall-bladder, with a vast amount of lipoid in a stroma normally scanty and relatively acellular, is strongly suggestive of an infiltration, and this has been quite definitely proved to be the case by Boyd,[5] who showed that whereas the cholesterol content of the wall of normal gall-bladders, estimated by colorimetric methods after extraction in chloroform, ranged from 0·5 to 1·7 per cent of the dry weight, and that of an inflamed, non-cholesterol gall-bladder was 0·36 per cent, the corresponding estimations for 'strawberry' gall-bladders reached the immense figures of from 34·6 to 60·5 per cent.

General Considerations.—Great controversy has raged, especially in French literature, over the relation of cholesterol infiltration to cholecystitis. Gosset[7] and his associates maintain that cholesterosis represents an aseptic process in stone formation. Chiray and Pavel,[8] Lecène and Moulonguet,[9] and others equally insist upon an inflammatory basis, accounting for the cases in which histological evidence is lacking by the assumption that a former cholecystitis has undergone complete resolution. Regarding cholesterosis as a non-inflammatory change, Mentzer has endeavoured to relate it to a general change in lipoid metabolism, and Stewart,[10] amongst others, has regarded it as a result of hypercholesterolæmia.

From the observations which have already been described it must be evident that hypercholesterolæmia is too inconstantly found to be regarded as essential, and the occasional absence of cholecystitis cannot be disregarded, in spite of the view quoted above. Moreover, infection and hypercholesterolæmia together do not necessarily result in cholesterosis (*see* the controls in

Table V), and clearly other factors must be sought for.   It is believed that these may be found in a consideration of the especial relation of the biliary tract to cholesterol metabolism.

The bile is, except for the milk during lactation, by far the most important vehicle for the excretion of cholesterol, and its cholesterol content, especially after concentration in the gall-bladder, may be high.   What effect the gall-bladder exerts upon the bile-cholesterol awaits proof.   Naunyn[11] has always maintained that the gall-bladder excretes cholesterol into the bile, whereas others believe that it reabsorbs some of the cholesterol into the blood-stream. Whichever view is right, it is believed that some dysfunction of the gall-bladder is intimately concerned in the production of cholesterosis; hence the strict localization of the deposits to the gall-bladder and their absence from the ducts. Before these various features are considered more fully, it will be of advantage to study certain cholesterol infiltrations in other sites in the body.

Other Cholesterol Infiltrations.—Pathological infiltrations with cholesterol, which may occur in diverse situations throughout the body, have been classified by Stewart[10] into two principal categories, according as they result from local tissue changes or from a general increase in the cholesterol content of the body.   In many of these infiltrations the microscopic appearance has much in common with that of the 'strawberry' gall-bladder, and the foamy cells in particular are frequently met with.   The cholesterol present is usually in the form of the ester, often admixed with other lipoids.   It is usually intracellular, but may be deposited in the extracellular tissues, in which case a foreign-body reaction of the giant-celled type may occur.   Occasionally the cholesterol occurs in an invisible form, in which it neither stains with fatty stains nor exhibits any optical activity, and can only be demonstrated by chemical analytical methods, being combined, in all probability with proteins, in a masked form.[12]

Certain of these infiltrations deserve especial mention, as they throw some light upon the etiology of cholesterosis.

Cutaneous Xanthoma.—The yellow cutaneous or subcutaneous nodules of this disease are characterized by the presence of foamy cells which closely resemble, both in form and lipoid content, the cells of the 'strawberry' gall-bladder.   In regard to pathogenesis, the important feature is the almost invariable finding of a raised blood-cholesterol content, and this is usually regarded as the essential etiological factor.   A second, localizing, factor is suggested in some cases, as where xanthoma followed a mosquito bite,[13] and this is supported by the experiments of Anitschkow,[14] who produced xanthomatous lesions in hypercholesterolæmic animals by the subcutaneous injection of aseptic irritants.

Xanthosis of the Fallopian Tubes.—This is a rare finding in cases of chronic salpingitis or pyosalpinx.   Pick,[15] and Daniel and Babès[16], have described cases in which cholesterol deposits occurred closely resembling those in the gall-bladder in naked-eye and microscopic appearance.   In some cases the cholesterol was distributed uniformly in the mucosa; in others it formed numerous yellow polypi.   In these cases there is no evidence of a raised blood-cholesterol index, and the *local* excess of cholesterol in the diseased adnexa has been regarded as of importance.

RELATION OF HYPERCHOLESTEROLÆMIA TO CHOLESTEROSIS.

It has already been indicated that on clinical grounds there is little evidence that a raised blood-cholesterol index can cause cholesterosis. In two-thirds of the cases in which it was estimated the index was normal, and, conversely, it is known that the blood-cholesterol index may reach such immense figures as 1250 mgrm. per cent,[12] yet fail to give rise to cholesterosis.

Experimentally, Blaisdell and Chandler[17] have upheld the view that hypercholesterolæmia *alone* may cause cholesterosis, for in rabbits they have shown that a prolonged course of feeding with cholesterol leads to the deposit of this substance in the gall-bladder wall. This finding, which I have repeated and confirmed, cannot, however, be accurately compared with cholesterosis in the human being, for in animals, if feeding with cholesterol is maintained, as in the experiments referred to, for a prolonged period, cholesterol is deposited in large amounts in the liver, kidney, spleen, adrenals, and other organs, and gives rise to gross atheroma of the aorta and other vessels—lesions which quite overshadow a rather scanty microscopical deposit in the gall-bladder wall.

The following is an extract from one of a series of experiments which illustrate this point :—

Experiment 1.—Cholesterol was administered to four healthy rabbits over periods from 11 to 15 weeks, each rabbit receiving daily, in addition to its usual portion of bran and greenstuff, 0·2 grm. of pure cholesterol, which was administered, for convenience, suspended in butter.

During the period of feeding one of the animals was pregnant on two occasions. The blood-cholesterol index in all cases was very markedly raised to many times its normal value.

At the end of the period the animals were killed. All showed gross deposits of cholesterol in the wall of the aorta and in many other organs, but in only two was there any trace of cholesterol visible in the gall-bladder wall. In these two cases minute droplets were visible, chiefly in the subserous coat of the gall-bladder and to a less extent in the mucosa, but this scanty deposit contrasted markedly with the appearance of the adjacent liver, in which large masses of doubly refractile material were visible.

In one animal at the end of three months the blood-cholesterol content had been raised from 105 mgrm. per cent up to the immense figure of 1136 mgrm. per cent. Excessive deposits of cholesterol esters were present in both kidneys, which were typical gross examples of 'myelin kidney' ; there was a considerable degree of aortic atheroma, and large deposits of cholesterol were present in the adrenals, ovaries, liver, spleen, and other organs ; yet the gall-bladder appeared perfectly healthy to the naked eye, and, microscopically, contained only minute traces of cholesterol.

RELATION OF INFECTION OF THE GALL-BLADDER TO CHOLESTEROSIS.

Diametrically opposed views are held in regard to the importance of the infective factor in cholesterosis. Whilst it is generally conceded that in the large majority of cases a greater or less degree of cholecystitis is present, occasional cases have been reported in which no histological evidence of infection is found. and in view of the fact that most papers on the 'strawberry' gall-bladder are based upon surgical cases which are usually brought to operation on account of an accompanying inflammation, these exceptional non-inflammatory cases are of particular importance.

Gosset and his associates have noted the absence of infection in certain of their cases, and Mentzer from autopsy studies confirms this. In the present series several cases have occurred in which little evidence of inflammation appeared to the naked eye, but in all of these with one exception the microscopic examination gave undoubted evidence of mild cholecystitis. In one gall-bladder, however, although a marked degree of lipoid infiltration was present, no trace of an inflammatory lesion could be found either by histological or bacteriological examination.

In their staunch advocacy of an infectious origin of cholesterosis, Chiray and Pavel have disregarded all histological evidence to the contrary, believing that a mild cholecystitis may disappear, leaving no recognizable trace behind it except the deposits of cholesterol to which it has given rise; but with our present knowledge of the diseases of the gall-bladder this view seems unsupported. Judging by our present criteria, therefore, it must be admitted that an infection is not essential, though undoubtedly of frequent occurrence, with cholesterosis.

Factor of Biliary Stasis.—It has already been stated that in most cases of cholesterosis the bile is dark and tarry, and this has been taken by some writers as evidence of undue stasis in the gall-bladder. This contention cannot, however, be supported. The concentration of the gall-bladder bile depends not only upon the amount of stasis which exists, but also on two other factors—namely, the bile concentration when excreted from the liver, and the absorptive power of the gall-bladder wall. Clinically, cholecystographic examination of several of the patients of this series showed that the gall-bladder decreased greatly in size after a fat meal, in some of the cases becoming almost emptied, and it may therefore be concluded definitely that biliary stasis has no part in the production of cholesterosis.

EXPERIMENTAL PRODUCTION OF CHOLESTEROSIS BY HYPERCHOLESTEROLÆMIA PLUS INFECTION OF THE GALL-BLADDER.

It was felt that the importance of the factors of hypercholesterolæmia and infection could be most satisfactorily demonstrated by animal experimentation, and, as either of these factors acting alone fails to give rise to gross lipoid infiltration of the gall-bladder, a combination of the two was next attempted : this proved completely successful.

The method employed to produce a chronic cholecystitis was the inoculation of avirulent organisms directly into the wall of the gall-bladder. It is well recognized that in a considerable proportion of chronically inflamed gall-bladders cultures taken from the wall will yield a growth of streptococci which are non-hæmolytic, slow-growing, and avirulent ; and A. L. Wilkie[18] has shown that if these organisms are injected between the layers of the gall-bladder wall, no acute inflammation occurs, but a slowly progressive chronic cholecystitis appears, at first localized to the site of inoculation, but later spreading over the whole gall-bladder. The whole process resembles that seen clinically in cases of mild or moderate chronic cholecystitis, in which inflammatory changes are chiefly localized to the outer coats of the wall, the mucosa remaining relatively intact.

The procedure adopted was as in the following experiment :—

Experiment 2.—A healthy male chinchilla rabbit was fed with 0·2 grm. of pure cholesterol in butter daily, along with its ordinary ration of bran and greenstuff, for

a period of 13 weeks. One week after the commencement of the feeding laparotomy was performed. The gall-bladder appeared healthy. With a syringe and fine needle an intramural injection of a saline suspension of streptococci was then made into the inferior wall of the gall-bladder at its mid-point. The streptococcus was one which had been isolated several months previously from a case of cholecystitis, and belonged to the *viridans* group. For the inoculation the growth from a 24-hour

FIG. 141.—Experimental production of 'strawberry' gall-bladder. In a rabbit, fed with cholesterol to raise the blood-cholesterol content, a mild chronic cholecystitis was produced by injecting avirulent streptococci into the gall-bladder wall. A typical 'strawberry' gall-bladder resulted, clearly recognizable to the naked eye. This section (stained with Sudan IV) shows large masses of cholesterol in the epithelium and stroma.

agar slope culture was suspended in 10 c.c. of saline solution, and about one minim was injected.

Thirteen weeks after the commencement of the experiment the rabbit was killed. At this time it was extremely well nourished and appeared healthy. The abdomen was free from adhesions, the scar of the operation wound being barely discernible. The gall-bladder was of average size; its inferior surface had an opaque, pearly-white appearance, and on palpation seemed thickened. Its deep

wall, when separated from the liver, appeared relatively normal. The other viscera showed relatively little change to the naked eye, though microscopically deposits of lipoid were visible in the liver and adrenal glands.

The gall-bladder contained a large semi-solid concretion and a few drops of turbid bile. The amount present was insufficient for an accurate estimation, but rough tests showed the presence of cholesterol in excess.

The inner aspect of the gall-bladder presented a striking appearance. Through its whole extent the mucosa was raised up into linear ridges of a bright yellowish-white colour, the whole appearance being very like that of a clinical 'strawberry' gall-bladder, and this similarity was further enhanced by the fact that close up to the commencement of the cystic duct the infiltration stopped completely, the cystic and common ducts being to all appearances free from lipoid.

In frozen sections from the gall-bladder (Fig. 141) the similarity to clinical cholesterosis was completely demonstrated, for the lipoid was found in the two regions where it would be expected—namely, in the stroma and the epithelial cells of the mucous membrane—and much of the lipoid conformed in physical and chemical characteristics with an ester of cholesterol; i.e., it was anisotropic, and it melted, with the production of Maltese crosses, at from 37° to 42° C.

Paraffin sections confirmed the similarity, for, in addition to numerous small cells of inflammatory origin, the stroma of the mucosa contained a number of typical 'foamy' cells, which were most marked in the rather prominent villi, but also extended into the deeper part of the stroma (Fig. 142). In sections stained with osmic acid these 'foamy' cells were seen to contain lipoid granules stained a faint grey.

In another rabbit, similarly treated except that the streptococcal inoculation was made only 4 weeks before the animal was killed, the appearance of the gall-bladder was even more striking. This organ, which was small and somewhat thickened, contained a few drops of fluid bile and a large soft yellow mass adherent to the mucosa. More fluid bile and a large soft yellow mass adherent to the mucosa. More careful examination showed, however, that this was incorrect, and in microscopic sections it was seen that the whole of this mass was composed of large 'foamy'-celled areas situated within the mucosa, the condition being that of a very much exaggerated 'strawberry' change.

FIG. 142.—Experimentally produced 'strawberry' gall-bladder. Paraffin section of gall-bladder seen in Fig. 141 (stained hæmatoxylin and eosin). Foamy cells in stroma give an appearance exactly like that of typical 'strawberry' gall-bladders in man. (× 150.)

mass, which was taken at first to be thick pus

It will be seen, then, that cholesterosis of the gall-bladder can be readily produced experimentally by inducing an inflammation of the gall-bladder in a hypercholesterolæmic animal. It remains to be shown how this experimental finding can be correlated with the clinical observation that either cholecystitis or hypercholesterolæmia may be lacking. It is believed that this correlation can best be effected by a study of the function of the gall-bladder in regard to cholesterol.

FUNCTION OF THE GALL-BLADDER IN REGARD TO CHOLESTEROL.

Two opposing views are held in regard to this relationship, namely : (1) That the gall-bladder secretes or excretes cholesterol into the bile ; and (2) That the gall-bladder reabsorbs a portion of the cholesterol already present in the bile. There is much to suggest that the latter is the correct view.

The strict localization of the deposit to the gall-bladder itself points to this mechanism, which is in accord with the known absorptive property of the gall-bladder in regard to several other substances ; and also the occurrence of cholesterol and other lipoids in the epithelium *of the tips of the villi* suggests that an absorption from the lumen is the route involved.

In the experimental field efforts have often been made to demonstrate the absorption of cholesterol from the bile, but these efforts have had little success. Other lipoids, on the contrary, can readily be shown to be absorbed into the gall-bladder mucosa.

Absorption of Other Lipoids.—The demonstration of lipoid absorption by the gall-bladder wall was first given by Aschoff[19] and later repeated by Mentzer.[4] The former introduced olive oil, butter, and sterile milk into the gall-bladders of dogs, the cystic ducts being ligated to prevent expulsion of the inoculum. In each case it was found that after a period of a few days lipoid deposits were present in the epithelial cells, whereas in control animals, in which simple ligature of the duct was performed, no such appearance was seen. Mentzer noted similar findings. Even after as short a period as half an hour the lipoid could be seen in the epithelial cells, and after longer periods it could be followed to the stroma and even to the vascular endothelium. No particles of fat could be observed in the lymph node draining the gall-bladder, and Mentzer therefore concluded that the absorption took place directly into the blood-vessels.

The following experiments are typical of many that have been carried out, using a variety of fatty and lipoid substances.

Experiment 3.—In a cat the gall-bladder was exposed by laparotomy, and the bile removed by a needle inserted at the fundus. In place of the bile about 1 c.c. of oleic acid (insufficient to distend the gall-bladder completely) was injected, the needle puncture being then closed by a fine silk ligature. To prevent expulsion of the lipoid, the common duct was ligated close above its entrance into the duodenum.

[In other experiments the cystic duct instead was ligated, with similar results. A disadvantage of ligating the cystic duct is that a certain amount of damage to the surrounding lymphatic vessels draining the gall-bladder is inevitable ; on the other hand, ligation of the common duct introduces the complication of a complete biliary obstruction, with consequent raising of the pressure within the gall-bladder. Control experiments, using both sites for ligation, were therefore always carried out.]

Two days later the animal was killed. The mucosa of the gall-bladder appeared undamaged, but throughout the entire organ it showed numerous milky-white, tiny deposits, scattered throughout the mucosa along the summits of the ridges—an appearance closely similar to that of a typical clinical 'strawberry' gall-bladder.

Microscopically this similarity was confirmed (except, of course, as regards the nature of the lipoid). In sections stained by osmic acid or by Sudan IV, innumerable fatty deposits were visible in the epithelial cells of the mucosa, in exactly the situation most characteristic of cholesterosis—namely, at the bases of the cells

just below their nuclei, and especially in those cells situated towards the apices of the 'villi'. In other sections the lipoid was sometimes found also in the more superficial parts of the cells, and in some the epithelium was completely loaded with fatty particles (Fig. 143).

The whole appearance of such sections so strongly resembles that of early cases of cholesterosis that it is difficult to believe that in the latter condition the cholesterol can have reached its site of deposition except by absorption from the lumen into the epithelium of the mucosa. The only respect in which the clinical condition differs from that induced experimentally is in the nature of the lipoid, which in the experiment here cited had the staining reactions of a fatty acid and failed to show anisotropism.
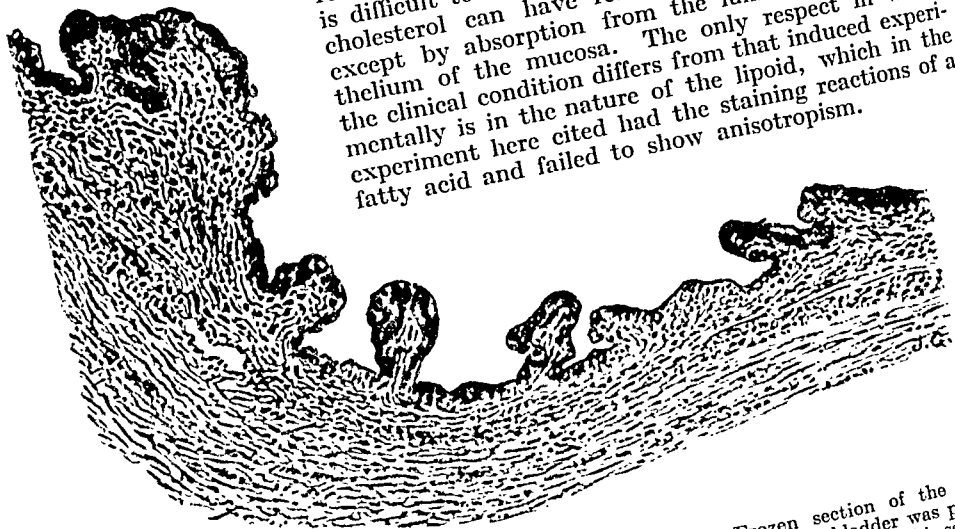
FIG. 143.—Absorption of lipoids by the gall-bladder. Frozen section of the gall-bladder of a cat (stained with Sudan IV). In this experiment the gall-bladder was partly filled with a lipoid (oleic acid), the cystic duct being tied to prevent emptying. This section (taken two days later) shows how a large amount of the lipoid has been absorbed into the cells of the mucous membrane. Olive oil, butter, and several other fatty substances behave similarly. The demonstration of the absorption of cholesterol is more difficult. (× 120.)

In similar experiments the absorption of butter, olive oil, and lecithin has been demonstrated.

Absorption of Cholesterol.—The demonstration of the absorption of cholesterol through the gall-bladder wall has proved difficult. Aschoff in 1906 showed that if cholesterol in olive oil is placed in the gall-bladder, though lipoid appears in the epithelial cells, it does not have the reactions characteristic of cholesterol. Mentzer performed similar experiments, using cholesterol ester, with equally negative results. In addition, cholesterol dissolved in oleic acid was used, and in this case it is stated that absorption took place, though it was not so marked as in the case of other lipoids. Apart from the simple statement, however, Mentzer advances no proof that the absorbed lipoid really was cholesterol, and, unless polariscope examinations are carried out, a fallacy may here creep in.

Experiment 4.—In a cat the bile in the gall-bladder was replaced by 1 c.c. of oleic acid, in which was dissolved 0·2 grm. of pure cholesterol. The common duct was ligated. Two days later the mucosa of the gall-bladder showed evident absorption, and microscopically there was lipoid in many of the epithelial cells. Polariscope examination showed, however, that this lipoid was not anisotropic, and even chemical tests of ethereal extracts of the gall-bladder wall showed but faint traces of cholesterol.

Working from another aspect, Torinoumi[20] has shown how difficult it is to prove that the gall-bladder can absorb cholesterol. Torinoumi, working with dogs, estimated the total cholesterol content of the bile in the gall-bladder before and at the end of a period during which the cystic duct was closed by ligature, and endeavoured to determine whether any reduction of this total took place. Several difficulties attended the performance of these experiments, especially the accidental production of inflammation in the gall-bladder, and the findings were therefore very variable. In those experiments, however, where at the end of the period the gall-bladders appeared healthy, there was a distinct diminution in their cholesterol content, so they do give some evidence of an absorptive function.

It is evident that the proof of the absorption of cholesterol, if it does occur, must be difficult to obtain, for the following reasons :—

1. *The experiments of Torinoumi indicate that absorption is very limited in extent*, possibly depending partly upon a relatively high concentration of cholesterol in the bile as compared with the blood, and slowing down as these concentrations equalize.

2. *The absorption may not be demonstrable by histological methods.* Little is known about the normal method of transport of cholesterol through the body, but it seems probable that the cholesterol is usually bound up with other lipoids in such a manner as to render it unrecognizable by its staining or physical properties. This masking of cholesterol is very evident in absorption through the intestinal mucosa. Thus, in a rabbit which for several weeks had been fed with cholesterol, microscopic sections from several regions of the intestinal tract showed no trace of doubly refractile material, although at the time of death some absorption of cholesterol must undoubtedly have been taking place. It seems possible that the passage of cholesterol through the gall-bladder mucosa may be similarly obscured.

3. In attempts to demonstrate experimentally absorption by the gall-bladder, the physical and chemical state and the environment of the cholesterol used must be of great importance and should correspond as nearly as possible to that present in the normal bile and tissues.

In the course of this investigation numerous experiments have been carried out with the object of giving histological demonstration of cholesterol absorption, but so far they have been entirely unsuccessful. In these experiments, which were carried out on similar lines to *Experiment* 3 above, cholesterol in a great variety of mixtures was used. Crystalline cholesterol, suspended in vaseline, agar-agar, or butter ; solutions of cholesterol in oleic acid or olive oil ; complex suspensions with lecithin and other lipoids ; and extracts of adrenal glands containing much cholesterol : all gave the same results—namely, that absorbed lipoid could be readily demonstrated in the gall-bladder wall, but this lipoid failed to respond to the tests for cholesterol. Although histological proof has been found lacking, it has been possible to demonstrate very clearly the absorption of cholesterol by other methods.

Experiment 5.—A supply of cholesterol, mixed with other lipoids as nearly as possible in the state in which it normally exists in the body, was obtained as follows : The adrenal glands were removed from a number of rabbits which for three months

had been on a diet rich in cholesterol. Frozen sections of these glands showed a large excess of cholesterol, chiefly in the form of esters. The glands were extracted in the cold with chloroform-ether mixture, and a sticky extract was obtained which also showed a high content of cholesterol esters. This extract was emulsified by means of lecithin in a small quantity of cat's bile.

Laparotomy was then performed on two cats, and the same procedure carried out in each. The cystic duct was carefully exposed and freed from the cystic artery, and cut across. With a fine Record needle inserted along the cystic duct the bile in the gall-bladder was withdrawn, and in place of it 1 c.c. of the prepared bile was injected. The cystic duct was then doubly ligatured and the wound closed.

Five days after operation both cats were killed. The gall-bladders, which appeared healthy, free from adhesions, with unimpaired blood-supply and lymph drainage, and with no evidence of leakage, were removed and their total contents carefully collected. Cholesterol estimation was then performed upon these contents, and at the same time upon 1 c.c. of the original injected fluid, all the steps of the three estimations being carried out together to minimize any error.

The results of this experiment are seen in *Table VI*, which shows that during the space of five days more than half of the cholesterol injected had gone from the gall-bladder. This amount far exceeds any possible error of estimation, and as every care was taken to prevent loss during the operative procedure or at autopsy, it seems justifiable to attribute it to actual absorption through the gall-bladder wall.

Table VI.—ABSORPTION OF CHOLESTEROL FROM THE GALL-BLADDER.

	CAT 89	CAT 98
Cholesterol injected into gall-bladder	34·425 mgrm.	34·425 mgrm.
Cholesterol present after five days	15·67 mgrm.	13·29 mgrm.
Amount absorbed	18·755 mgrm.	21·135 mgrm.

It is concluded, therefore, from these experiments that cholesterol, when in excess and in certain physical mixtures, can be absorbed by the gall-bladder wall, probably in masked form, which prevents its histological demonstration.

DISCUSSION.

It is believed that there are now sufficient data available to justify a tentative opinion as to the etiology of cholesterosis.

The fact that similar infiltrations with cholesterol in various tissues of the body are frequently or usually associated with two demonstrable lesions—namely, an increase in the cholesterol content of the blood and an inflammatory change—necessitates a careful consideration of these factors in particular.

It cannot be doubted, for the reasons already cited, that neither of these factors alone can give rise to cholesterosis, but it is an attractive hypothesis, and one frequently maintained, that they are jointly responsible. Unfortunately this does not completely agree with the available facts, for either hypercholesterolæmia or cholecystitis may be lacking, the former indeed commonly.

In addition, the frequent cases in which hypercholesterolæmia and mild cholecystitis exist, yet fail to give rise to cholesterosis, indicate clearly that other causative factors must be sought for. It seems probable that an indication of the nature of these may best be obtained by a careful consideration of the normal functions of the gall-bladder in relation to cholesterol.

From the experiments described above it seems clear that the gall-bladder can absorb cholesterol from the bile. This does not necessarily mean that such an action goes on to any appreciable extent in the normal gall-bladder (the experiments of Torinoumi indicate that such action must at least be very limited in degree), and it is likely that an essential feature in determining the absorption of cholesterol is the concentration of this substance in the bile, absorption taking place only when it is in excess. Moreover, it is clear that the cholesterol, when absorbed into the healthy mucosa, yet remains indistinguishable under the microscope, its characteristic optical properties being masked in some way not fully understood.

This being the case, it becomes evident that deposit of visible cholesterol in the gall-bladder (cholesterosis) postulates essentially two processes: (1) Absorption of cholesterol into the mucosa, depending probably upon an increase in the cholesterol content of the bile; and (2) Some change which unmasks this absorbed but invisible cholesterol, and which furthermore prevents or delays its transport and leads to its accumulation in the mucous membrane.

At this point we may see how it is possible to link up this hypothesis with clinical observations.

1. An increased cholesterol content of the bile was found clinically in all the cases in which the estimation was carried out. In 17 of the total cases, moreover, it had progressed to the formation of stones. This cholesterol increase *in the bile* is regarded as a primary factor of importance; the blood-cholesterol may or may not be increased. In the experimental production of cholesterosis (as in *Experiment* 2) an increase of blood-cholesterol is a necessary intermediate step in raising the bile-cholesterol, but there is much evidence that in man the latter alone may be increased.

2. In the second essential process we can see how the factor of cholecystitis may be linked up with the pathogenesis of cholesterosis, for it is believed that the part played by the inflammation consists simply in interfering with this absorptive process, so that the absorbed cholesterol is rendered visible and at the same time is accumulated in large quantity in the gall-bladder wall.

The exact rôle of the inflammation is open to speculation. Chiray and Pavel[8] have suggested that it acts by actual blockage of the lymphatic drainage of the gall-bladder; but against the acceptance of this hypothesis are two facts, namely: (1) There is no proof that absorption usually occurs by the lymphatic path; (2) There is no histological evidence of lymphatic obstruction and no œdema or fibrosis of the gall-bladder wall.

A more feasible hypothesis would appear to be that the inflammatory process occurs in virtue of some chemical action directly upon the absorbed cholesterol which would at the same time render the cholesterol visible, interfere with its normal transport, and lead to the characteristic endothelial

response. Such a hypothesis has the additional advantage that it is also applicable to those cases in which no inflammatory element is recognizable. In these cases one may presume some non-inflammatory change in the nature of the absorbed cholesterol, which prevents its transport away from the gall-bladder.

SUMMARY.

1. Cholesterosis of the gall-bladder, which includes the so-called 'strawberry' change and also cholesterol polyposis, consists essentially of an infiltration of the epithelium and the stroma of the mucous membrane with lipoids, and especially with cholesterol. In the stroma a characteristic feature is the presence of large 'foamy' cells of endothelial origin.

2. Cholesterosis is of frequent occurrence. It is a condition chiefly of middle life, and the incidence bears no relation to sex or social status.

3. It is usually associated with cholecystitis, especially of mild degree. Gall-stones are frequently present, especially 'pure' cholesterol stones.

4. Cholecystography indicates that in uncomplicated cases two functions of the gall-bladder (concentration of the bile, and the emptying in response to fats) are not affected.

5. The cholesterol content of the blood is raised in some cases, but is often normal.

6. Symptoms, even in uncomplicated cases, are extremely varied, and the diagnosis is correspondingly difficult.

7. Treatment by cholecystectomy is the most rational procedure, and appears to yield satisfactory results.

8. Experiments are described which indicate : (a) That cholesterosis may be most readily brought about in the rabbit by the association of a prolonged state of hypercholesterolæmia with a mild chronic bacterial cholecystitis ; (b) That cholesterosis does not result simply from the deposit of an excess of cholesterol from the blood, but is intimately linked up with the function of the gall-bladder in regard to cholesterol.

9. In an experimental investigation of the absorbing function of the gall-bladder it has been shown : (a) That absorption of several other lipoids from the bile is easily demonstrable ; (b) That cholesterol is absorbed in unrecognizable form, its presence in the mucosa being obscured, probably by admixture with other lipoids. Absorption of cholesterol from the bile probably only occurs when it is present in excess.

10. The conclusion is drawn that cholesterosis results from two essential primary changes : (a) An increase in the cholesterol content of the bile, which leads to the absorption of cholesterol into the mucous membrane of the gall-bladder : this increase depends probably upon several factors which are incompletely understood. In some cases it is associated with a similar increase of the blood-cholesterol. (b) A change in the physical and chemical state of the absorbed but invisible cholesterol, which renders it optically active and recognizable, and which by preventing its transport leads to its accumulation in the gall-bladder wall. This change is most frequently due to an inflammation of the gall-bladder.

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SPLENECTOMY FOR EGYPTIAN SPLENOMEGALY:
AN ACCOUNT BASED ON A RECORD OF 390 CASES.*

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SPLENOMEGALY amongst the Egyptian fellaheen is one of the most disabling diseases to which they are prone. There is no doubt in my mind that this enlarged spleen is due to heavy infections of bilharzia of the rectal or *Bilharzia mansoni* types. Proof of this statement is quite another matter, but I am confident it will be forthcoming, and my only regret is that I have no opportunity for field work in this connection, but presently I feel assured the Bilharzia Committee will discover the clue.

I have been performing splenectomy now for the last nine years, and have removed a total of 390 spleens, and I must acknowledge my debt to Owen Richards, at one time surgeon at Kasr el Aini Hospital, who did the preliminary work on this operation, and it is largely through his experiences that I am now accorded a certain measure of success. But it is astonishing how difficult it is to impress the young surgeon with the difficulties of the operation and the precautions that have to be taken, with the result that they get a hundred per cent mortality in their first few cases, and naturally become frightened, and persuaded that the operation is not worth the risk.

It is readily accorded that this procedure is extremely dangerous: not only is the operation itself a dangerous one, needing a gentle hand, a quick eye, and coolness in an emergency, but the material to work on is of the unhealthiest nature. For this reason it cannot be too forcibly impressed upon surgeons wishing to perform this service that the patient must be very carefully prepared before being subjected to the risk of the operation.

I find surgeons examining the stools and urine of these anæmic patients, and if no bilharzia ova or ankylostoma eggs are found, they proceed to operate at once, with fatal results. Whether eggs are found or not, it must be presumed that the patient is full of the common Egyptian parasites, and carbon tetrachloride and a full course of tartar emetic and a course of antisyphilitic treatment must be given and the patient built up by nourishing food. This entails a stay in hospital for at least one month to six weeks. After all this preparation my immediate mortality (by immediate I mean those patients who do not leave hospital alive) is 13 per cent. On following-up patients I find this figure increased to 19 per cent by those who die after getting back to the villages—that is, within two or three months.

I do not choose my cases, but operate on all that come to me if they can

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possibly stand the operation, even patients with ascites, which is an unfavourable factor. By choosing cases this mortality can be reduced to 5 or 6 per cent, but 20 per cent will compare favourably with the 40 to 50 per cent mortality of the pioneers in surgery of cerebral tumours, and doubtless we shall reduce our mortality rate as they have reduced theirs in the light of experience.

The difficulty in a country like Egypt is the following-up of patients, and without a good follow-up system a surgeon is very apt to get wrong ideas of his work and statistical results. I have endeavoured by a system of questionnaires sent each year through the police to the omdah or headman of the village to get replies from my cases for three years in succession. The questionnaire is simple: Is the patient still alive? Has he increased in weight? Does he feel better than before the operation? This paper is returned to me:

FIG. 144.—A typical case of splenomegaly before operation, with another case one year after splenectomy.
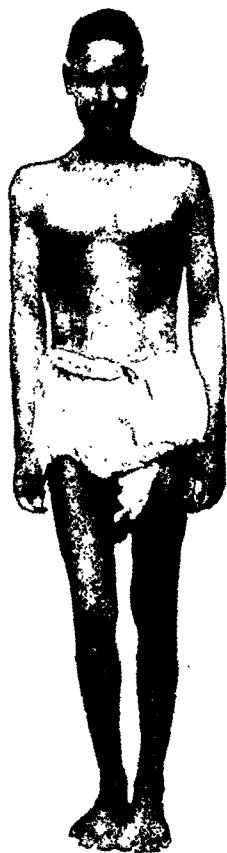
FIG. 145.—Photograph of a patient thirteen months after operation.

I find no trace of 6 per cent of my cases, indifferent health in 5·5 per cent, death in 19·5 per cent, good reports in 69 per cent. A good report of 69 per cent is my justification for allowing the patient to undergo the grave risk of the operative procedure, because it must be understood that without operation their expectation of life is extremely limited. *Figs.* 144, 145 show the good results that can be obtained.

The sexes are probably equally involved, but naturally in Egypt the women do not come forward so readily for treatment as the men, their economic value being so much less. Neither is the accommodation in our hospital sufficient for their needs. My cases show 80 per cent men. The ages vary from 8 to 45, the majority being between 15 and 25.

The geographical distribution is shown on the map (*Fig.* 146), but more work has to be done on this question. I am inclined to think that villages
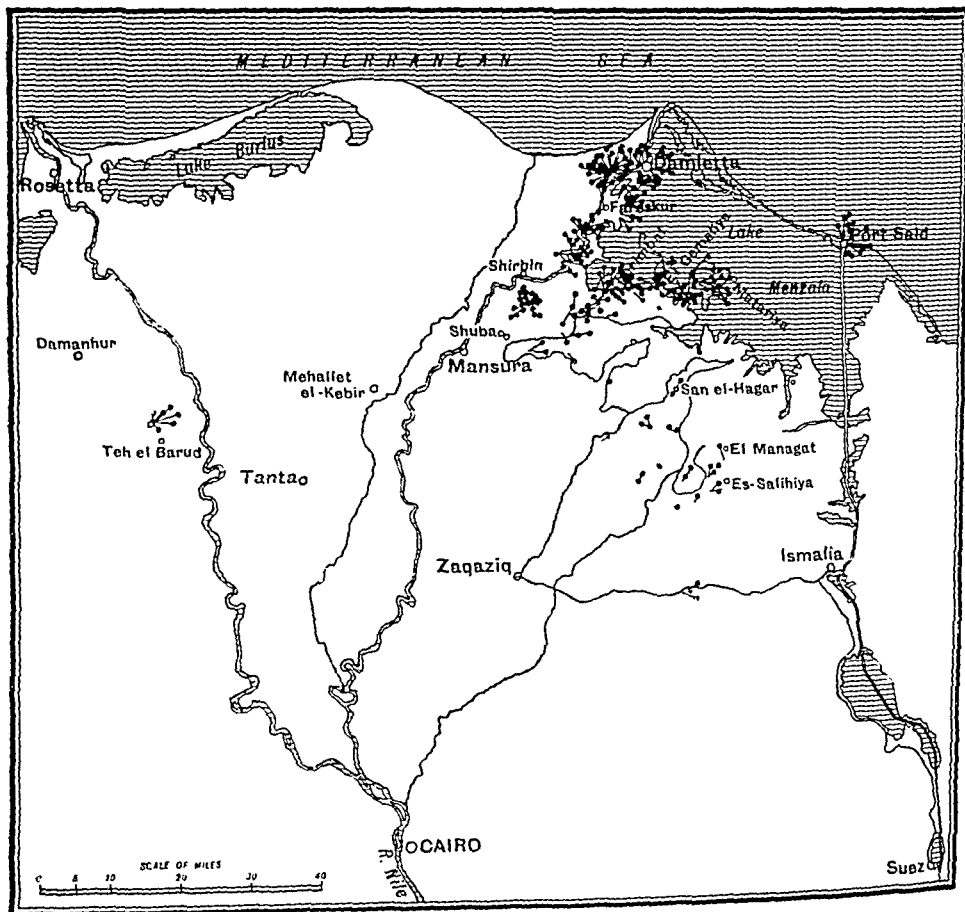
Fig. 146.—Map illustrating the geographical distribution of cases operated upon.

at the end of canals are more heavily infected than elsewhere; but proper surveys, with the help of the Irrigation Department and the Entomological Department as to the distribution of the snails, will demonstrate this more clearly.

Blood-counts on patients will show white count 6500 and red count one or two millions. A differential count will give: polymorphs 66 per cent, lymphocytes 20 per cent, large mononuclears 6 per cent, transitionals 6 per cent, eosinophils 1 per cent, mast cells 1 per cent. The fæces show *Bilharzia*

mansoni, and the urine may be infected also with *Bilh. hæmatobia*, and in addition the fæces may show amœbæ, trichomonas, ascaris, and all the flora and fauna of the country.

The weight of the spleens removed averages 1½ kilo., and varies between 800 grm. and 7 kilo.

PREPARATION OF THE PATIENT.

When a patient is admitted for splenomegaly with a view to operation I give as a matter of routine a dose of carbon tetrachloride varying from 2 to 4 grm. according to age and weight ; a full course of tartar emetic intravenous injections 0·12 grm. every two days for twelve injections ; and a course of injections of '606' or corresponding drug. I give a mixture of rhubarb and soda for the first week (this is a splendid cleaner of the intestinal tract), and subsequently a mixture of iron and arsenic and a full nourishing diet including 'fool nabet', that is, beans which have been allowed to germinate forty-eight hours in water. These are cooked quickly—four or five minutes only—in a good soup. They have a remarkable effect on the pellagrous cases and others suffering from a vitamin-deficient diet. This course of treatment lasts from five to six weeks, when the patient is greatly improved in general health and can stand the shock of operation.

THE OPERATION.

The evening before operation the patient is purged and given an injection of pneumococcic vaccine. This is essential, as, failing this, the patient will almost certainly die from pneumonia after the operation. In fact, about 5 per cent have pneumonia in spite of the vaccine, but with another dose of vaccine they generally pull through. A dose of morphine and atropine is given half an hour before the operation.

The patient sits on the operating table and places his hands over his ears and bends down his head. This opens up the spinal vertebræ, and with a long fine needle on a 2-c.c. syringe, I tap the spinal fluid through the eleventh dorsal space, trying not to let any of the fluid escape and drawing it into my syringe. I then inject about 1·8 c.c. of the stovaine solution, using stovaine 0·04 grm., sodium chloride 0·0011 grm. per c.c.

The patient lies down promptly on his back, and I do not practice raising the legs or lowering the head, as I find there is a smaller percentage of headache after the operation by omitting these procedures. The anæsthesia is good and sufficient for the whole operation ; only very occasionally is a little chloroform needed in addition.

Standing on the right hand side of the patient, I make an incision varying in length with the size of the spleen. This incision starts at the costal margin and runs parallel to the mid-line, dividing the left rectus muscle into two equal parts. I incise the skin and rectal sheath, and make a small incision through the intermuscular septum and separate the muscle with a sweeping action up and down with my finger. The peritoneum is then incised. The exciting part of the operation now follows, as the whole hand

is inserted to find out what adhesions are present between the spleen capsule and the parietes, as the difficulties of the operation depend on the adhesions, and it is impossible to foretell the nature and extent of these obstructions.

In a favourable case, with no adhesions, or only slight easily detached ones, the whole spleen can now be delivered out of the abdominal wound. A dozen big clamps are ready on the instrument table, and I clamp the pedicles of the splenic artery and vein all together with three or four clamps placed in juxtaposition, cutting off the spleen between the third and fourth clamp. The pedicle is then transfixed with a long pedicle needle threaded with a black and white linen thread—a point I learnt from T. de Martel in Paris. Linen is better than silk, and ties in a knot that does not slip. Black and white threads enable one to know at a glance which is which and whether the ligatures are interlocked or not. This first ligature is put in the space revealed by releasing No. 2 clamp, and as it is tied I release No. 1 clamp and allow it to be tied tight. Another ligature is then tied round the whole pedicle in the position of No. 1 clamp, and then a third is tied in place of No. 3 clamp. Various modifications of this procedure have to be undertaken according to circumstances. Very often there is a large vessel running from the greater curvature of the stomach to the hilum of the spleen. I pick up the lesser omentum and tie it off, and thus expose the true pedicle of the spleen.

Frequently there is a very strong adhesion from the splenic flexure of the large intestine to the spleen, and sometimes there are strong adhesions between the spleen and the under-surface of the diaphragm. These have to be broken by the fingers, and after the removal of the spleen, my assistant putting in a wide retractor, I have to pick up these bleeding points with a long bullet-nosed clamp and tie them off. Care is taken to stop all bleeding and clean out the cavity before shutting the abdomen.

The peritoneum is sewn with a continuous chromic catgut No. 0 or 1, and then, with a long Reverdin's needle, three or four supporting silkworm-gut sutures are put in through the skin and the rectus muscle. I then join the tendinous septum of the rectus with a catgut stitch, and subsequently sew up the external sheath of rectus with continuous chromic catgut No. 1 or 2. The skin is closed with Michel's clips and the silkworm gut tied, leaving the ends long, which are again tied over a sausage-shaped roll of dressing to act as a splint.

I have had no cases of paralysis of the inner portion of the rectus muscle in spite of the nerve-supply being divided. I think that breaking the muscle fibres apart with the fingers, instead of cutting, probably pulls the nerve-fibrils out and leaves them to spread quickly across the wound during repair; also, I take it, muscle fibres being contiguous go into contraction with the outer half of the muscle out of sympathy. I am not in favour therefore of the incision which has been suggested for this operation—namely, one starting at the tip of the eleventh rib and running transversely across towards the umbilicus and dividing the rectus muscles. I find no particular advantage in the exposure of the field of operation, and there is peculiar difficulty in sewing up the divided rectus.

After operation patients are kept without anything to drink for twelve hours, my experience being that, given the chance, they will fill their

stomachs with water, and may start hæmorrhage from some unsuspected vessel. As a rule no rectal saline or intravenous blood transfusion is given, as I find that, although the patient may have lost a large amount of blood, he soon makes it up again.

Diet from the beginning is strictly fever diet, and only after five days is a purge given and a nourishing diet commenced. As a rule, patients go out after fifteen days, weak and happy, with a bottle of iron and arsenic, relieved of the intolerable weight in their abdomens, and in two or three months are really fit for work.

CONCLUSIONS.

1. Splenectomy is a dangerous operation requiring especially careful preparation of the patient.

2. The improvement in general health only to be obtained by its means justifies the risk.

THE CAUSATION OF MULTIPLE EXOSTOSES.

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THIS condition has been variously described as multiple exostoses, multiple endosteomata, and diaphysial aclasis. All these terms describe to some extent the pathological process involved, for projecting exostoses are present, the cancellous bone is of irregular and abnormal growth, and the ends of the diaphysis are unmodelled. The occurrence of these multiple irregular outgrowths at the ends of the long bones, associated with deficient growth in length and irregularity of contour, has long given rise to dispute among those interested in the problems of bone growth and bone pathology. The problem of modelling is itself ages old, for John Hunter.[1] in his lectures on the "Principles of Surgery", wrote: "Absorption must necessarily go on to keep the bone in its proper shape, hence I call this the modelling process."

FIG. 147.—The bones of the left forearm of a boy, age 14. Note the tilting of the lower radial epiphysis, the absence of the lower ulnar epiphysis, and the inequality in length of the bones.

Many cases of this condition have been described, and it is well known to all surgeons and pathologists, so that only a brief résumé of its salient features as affecting the present problem will be given.

No definite information is available as to the exact date of appearance of multiple exostoses. They are not found in embryos or fœtuses, but cases are recorded at the age of two. When the lower end of the ulna is the site of an exostosis the normal ossification of its epiphysis is interfered with, indicating that the process is well established before the age of three (*Fig.* 147). Either sex may be affected. The subjects are of less than the normal stature, owing to the deficient growth of their long bones. Certain bones are never affected; the carpus and tarsus, vertebræ, sternum, and skull are always free from any abnormality, and also the epiphyses of the long bones. It is thus clear that bones developed purely within cartilage or membrane escape, and that only those in which there is additional membrane bone laid down subperiosteally over endochondral bone are affected. The condition is often hereditary, though a history of this is not always obtained. An association with rickets has not been established, but there is a definite association with the occurrence of multiple enchondromata.

Types of Multiple Exostoses. — A number of different forms of multiple exostoses may be recognized, frequently occurring in the same case. The most common are those which occur at the extremities of the long bones, and appear as globular or cauliflower-shaped projections from the cylindrical mass of un-modelled bone (*Fig.* 148). The projections may also take the form of elongated spikes, in which case they are always directed away from the epiphysis, and are nearly always broader at the base than at the apex (*Fig.* 149). In this respect they differ markedly from the single pedunculated exostosis.

In addition to those originating from the region of active growth, we find exostoses occurring near the secondary centres of ossification, such as the gluteal ridge of the femur or the vertebral border of the scapula. These are usually

FIG. 148.—A lateral view of the knee-joint of a youth, age 17. Note the large cauliflower-shaped exostosis on the femur, the globular one on the tibia, and the trans-lucent appearance of the upper end of the tibia.

cauliflower-shaped. A few seem to have no connection with any ossification process, and appear as small isolated projections from the centre of the shaft of a long bone, frequently at points of tendon insertion or of muscle origin. These are usually pedun-culated. It should be noted that these single exostoses occurring from points of tendon insertion or of muscle origin are the only ones which project from a nor-mally shaped area of bone.

Structure of Exostoses.—It is instructive to recall the mode of growth of the common single pedunculated exostosis, unassoci-ated with any other skeletal abnormality. It is considered likely that a portion of the peri-phery of the growth disc has become displaced on to the

FIG. 149.—The knee-joints of a girl, age 9, showing spiculated exostoses. The alteration of arrangement in the cancellous bone of the affected area is well shown.

surface of the shaft, possibly by the pull of the periosteum attached to it. It then continues to grow, its main growth taking place at a right angle to the growth disc. The resultant of the forces in the two directions of growth finally brings the exostosis into a line directed away from the growth disc and at an angle to the shaft of about 30°. It grows by means of a cap of rapidly dividing cartilage which covers its enlarged extremity, and is identical in appearance with a growth disc (*Fig.* 150). The stalk or shaft of the exostosis is always narrower than the cap of cartilage which gave rise to it. Ossification of this cap of cartilage occurs about the age of 20.

FIG. 150.—A pedunculated exostosis growing from a bone of normal contour by means of a cap of cartilage. (Diagrammatic.)

Multiple exostoses are also covered by a thin layer of cartilage until the age of 20, when this layer is replaced by an egg-shell covering of compact bone. The cartilage-covered area extends from the diaphysial growth disc to the point at which the normal contour of the shaft begins, which is always marked by the presence of an out-turned spur or lip (*Fig.* 151). Sections of this surface layer show that the cartilage cells are behaving in the same way as the cells of the diaphysial disc—that is to say, they are dividing and adding more and more cells on their deep surface.

Some of these cells are being replaced by compact bone, which forms an incomplete layer beneath the cartilage. Many gaps are present, and these frequently contain large multinuclear cells. The appearance of the type of growth occurring from the surface cartilage closely resembles that occurring from the diaphysial disc in rickets, though this fact should not be construed into an association between the two conditions.

The cancellous bone underlying the surface cartilage is excessively spongy and fragile, the spiculæ are small and irregular, and the interstices are large and filled with myxomatous tissue. The irregularity of the trabeculæ in the cancellous bone is well shown in radiographs, and may be compared with the characteristic appearance of normal cancellous bone, which has been beautifully illustrated by Murk Jansen.[2]

Bone Modelling.—The process of bone modelling has long been an embryological mystery. The bone once formed increases in length by apposition from the growth disc, and in diameter by the apposition of subperiosteal bone. As new bone cells are formed

FIG. 151.—The right hand of a boy, age 14. Note the out-turned spurs marking the termination of the compact bone at the lower ends of the radius and ulna. Several of the phalanges are involved.

from the growth disc, the broad end adjacent to the epiphysis is displaced towards the centre of the shaft. It has always been assumed that the portion of bone which originated from the periphery of the disc must be removed in order to maintain the contour of the shaft. This process is referred to by Jansen[3] as 'tubulation', and is explained as being brought about by the active remodelling of osteoclastic cells (*Fig.* 152). This whole conception is contrary to the new evidence obtained from tissue culture. Miss Fell[4] has shown that the cartilage cells from a growth area arrange themselves in a definite manner which determines the shape of the bone. It is not that certain peripheral cells are removed in order to produce the normal contour of a long bone, but that the process of cell growth is so perfectly balanced as to bring this about. The two processes of the formation of perichondral and endochondral bone from the subperiosteal tissues and the growth areas respectively go on hand in hand. As there is no evidence of the occurrence of multiple exostoses in the embryo or the fœtus, and as the condition
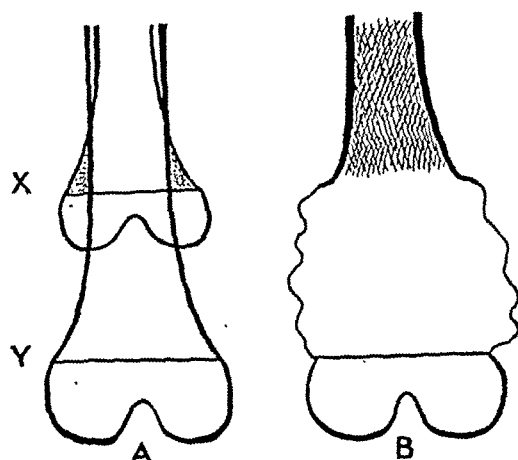
Fig. 152.—A, Illustrating Jansen's tubulation theory. The stippled area represents the portion of bone to be removed during the process of increase in length from X to Y. B, A bone equal in length to Y, showing how the out-turned spurs indicate the position of the growth disc immediately before the process of irregular growth commenced.

is not usually noticed until the third year or later, it is fair to assume that it is not due to any congenital defect in the system of bone modelling.

Conclusions.—Murk Jansen,[3] in his essay on the " Dissociation of Bone Growth ", ascribes the causation of multiple exostoses to a dissociation of resorption and tubulation, and mentions no connection between the surface cartilage and the growth of the exostosis. If the defect were merely the failure of the osteoclastic remodelling, a normal formation of bone in respect of length and structure would be found, with possible surface irregularity due to defect in the laying down of surface compact bone which goes hand in hand with absorption. The normal length, however, is not found, and irregularities occur both on the surface and in the medullary cavity. Moreover, up to the time of cessation of bone growth, growing cartilage is found on the surface of the exostosis.

The origin of this surface cartilage would appear to be the key to the situation. It is actively growing, giving rise to osteoid tissue and finally, by replacement, bone. Virchow first drew attention to the presence of growing cartilage on the surface of the exostoses, and though his explanation of its derivation is discarded, probably correctly, by Jansen,[3] yet the facts are basic ones and lend themselves to an alternative theory.

The exostoses are most numerous and best marked at the areas where normally the greatest growth of an individual bone takes place, and are most

frequently found at the upper end of the tibia and the lower end of the femur. This association with the areas of growth would suggest the derivation of the cartilage from which the exostoses increase in size to be from the growth disc, the edges of which have become pulled upwards over the surface of the meta-physis. This is analogous to the growth of the single pedunculated exostosis from a cap of cartilage, which is a completely isolated portion of the growth disc. It is a matter for speculation how this spreading out-wards and upwards of the edges of the growth disc is brought about. The disc is slightly concave, and the periosteum of the shaft is attached to its circumference. Should the growth of the periosteum and the periosteal bone fail to keep pace with the increase in length of the shaft, the peripheral growing cells become displaced, and in their new situation produce an irregular growth of bone. It is not, however, sufficient to ascribe the condition to a peripheral change alone, as imperfect and irregular growth is taking place from the growth disc as well as from the surface cartil-age, and the type of spongy bone laid down by the two sets of cells is identical. The altera-tion of the normal struc-ture and arrangement of the cancellous bone is very apparent in radio-grams of the condition, and normal cancellous bone does not appear until the normally modelled shaft is reached. Growth does not even take place at an equal rate all over the disc, which is proved by the tilting of the epiphysis (see *Fig.* 147). In a bone such as the femur, for example, two points on opposite sides of the shaft would always have, in normal growth, the same relative distance from the growth disc. In multiple exostoses the spurs marking the commencement of modelling are rarely at the same level, indicating that the process commenced first on one side of the disc rather than over the disc as a whole.

FIG. 153.—The hand and forearm of a girl, age 14, showing multiple ex-ostoses associated with multiple enchondromata.

FIG. 154.—A youth, age *17*, with multiple exostoses. Note the general deformity of the limbs and the pre-cocious development of the genitalia.

In this connection one point must be considered—the association with multiple enchondromata, which probably originate from a failure of ossifica-tion in the centre of the disc (*Fig.* 153). In addition to the occurrence of enchondromata, which are often regarded as innocent new growths rather than as growth defect, there is the rare appearance of an osteogenic sarcoma

in the exostoses. The theory of a neoplastic basis for the whole condition must, however, be rejected, because the growth of the exostoses ceases at 20 or 25. It also affects many bones and is to a large extent hereditary. The probability is that there is some defect in the internal secretions controlling bone growth, such as the pituitary or genital gland secretions. Jansen mentions that some of the cases show gigantism (*Fig.* 154). It is well known how the processes of bone growth can be interfered with by alterations in diet, and in the stimulus provided by the internal secretions.

It is clear that such a complicated condition cannot be produced by a mere failure in tubulation, or by vascular disturbance, but that, as Keith[5] originally suspected, the cause must lie in the abnormal behaviour of the cells of the growth disc, and the consequent failure of the subperiosteal bone formation to keep pace with it. An abnormal stimulus affecting the centre of the disc alone, and interfering with the process of ossification, would produce an enchondroma ; one affecting a localized portion of the periphery, a single pedunculated exostosis ; while a more general stimulus affecting the growth discs of all the long bones would produce multiple exostoses.

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ENDOTHELIOMA OF THE NASOPHARYNX: AN INFILTRATING TUMOUR AT THE BASE OF THE SKULL.

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THE tumours which I refer to under the name of 'endothelioma of the naso-pharynx' have long been recognized, and were shortly described in this country as long ago as 1911, by Mr. Wilfred Trotter,[1] in a lecture given before the Medical Society of London. That they have not received more attention is due partly to their actual rarity, partly to the fact that they still frequently pass unrecognized, and partly also to their almost unique unfavourability for surgical removal. The recent introduction into general use of radium treat-ment by means of 'seedling' tubes may, I think, render their early diagnosis a matter of practical as well as theoretical interest, as there is some evidence that this type of growth is susceptible to the influence of radium, and if the difficulties of its accurate application can be overcome, I believe there is ground for hope in this method of treatment. To carry out treatment by this means it is essential that the surgeon should have an accurate knowledge of the method and direction of spread of the tumour.

The disease is one which can occur within wide limits as regards age, and in either sex. Of the nine cases which I propose to use in order to illustrate this paper, three were women and six men. The ages of two of the men were 29 and 31 respectively; of the rest of the patients, four were between 50 and 60 years of age, and three between 40 and 50. The tumour has been regarded as one peculiarly apt to affect the young adult male, but my series is too small to permit of any conclusions, and all that can be said on the subject is that the tumour may occur in young adults, but may equally well be met with in people of more advanced years.

The clinical manifestations of these tumours are so varied that it is no easy matter to classify them, or to state the clinical evidences which justify the inclusion of any particular tumour in the group. Some cases show a quite unmistakable combination of symptoms, while the claim of other cases to belong to the group rests on the occurrence of only one or two of the clinical signs, combined possibly with histological evidence.

I shall attempt to describe these growths under seven principal head-ings: (I) *The clinical appearance and direction of spread of the primary growth;* (II) *The structures invaded by the primary growth;* (III) *The clinical character-istics of the glands invaded by the growth;* (IV) *Remote metastases;* (V) *The early signs and symptoms of the growth;* (VI) *The microscopic appearances of the growth;* (VII) *Possible lines of treatment.* To illustrate these points I propose to quote the case records of several patients who have come under my notice in the last few years.

I. THE CLINICAL APPEARANCE AND DIRECTION OF SPREAD OF THE PRIMARY GROWTH.

The primary site of the tumour is to a certain extent obscure, and must, in the present state of our knowledge, be deduced from the early symptoms. Reference to the table of early symptoms which appears in the later part of this article suggests that the tumour very soon comes into relationship with the Eustachian tube, the wall of the pharynx itself, and the 5th nerve. This places the site of origin of the tumour fairly accurately, but whether the growth originates actually in the wall of the nasopharynx is not easy to decide. I am not aware that any case has been recorded in which the symptoms of one of these tumours were present without a palpable mass in the lumen of the nasopharynx, but the syndrome is hardly sufficiently well recognized for such an eventuality to attract attention. From the clinical characteristics of the growth it may be said with certainty that it is not an epithelioma arising in the mucous membrane of the pharynx. The term ' endothelioma of the nasopharynx ' is sanctioned by usage and is sufficiently accurate, provided that one remembers that the symptoms are usually those of an infiltrating tumour at the base of the skull rather than those of a growth in the lumen of the nasopharynx.

When seen in the nasopharynx the tumour is commonly small and sessile and lies in the lateral wall of the pharynx in the region of the opening of the Eustachian tube. It is pink in colour, firm to the touch, and may be only appreciable to the examining finger as a hardening in the wall of the pharynx. Ulceration is either absent or slight in the early stages, and a study of cases in more advanced stages reveals a curious characteristic of the growth—that is, its tendency to spread widely beneath the mucous membrane of the mouth without causing ulceration. The tumour reaches the mouth, I think, by extension down the levator palati muscle. In any case it appears at the junction of the hard and soft palate on one side; and from this position extends widely in the submucous tissue, producing a very pronounced thickening in the alveolus, sometimes as far forward as the incisor region. The older parts of the tumour may ulcerate, but submucous extension goes far in advance of the ulceration.

Any tumour which spreads in the mouth in this manner is under suspicion of a nasopharyngeal origin, and if the tumour has appeared at the junction of the hard and soft palates and has been preceded by neuralgic pain in the distribution of the trigeminal nerve, the suspicion becomes practically a certainty. In two of the cases which I shall presently quote (*Cases* 4 and 5), persistent pain of trigeminal distribution preceded the appearance of the tumour in the mouth by several months, and I have no doubt that the pain in these two cases was due to the unsuspected presence of a nasopharyngeal growth. The tendency to submucous spread without involvement of the mucous membrane can be seen sometimes in the microscopic sections (*see Fig.* 157).

In exactly the same way as the tumour burrows beneath the mucous membrane of the mouth it will burrow in the deeper planes. This leads to infiltration of muscles, to a wide involvement of the structures at the base

of the skull, and may ultimately show as an obvious extension on the outer surface of the skull. Two of the cases which I have personally observed showed this sign. A photograph of *Case 2* is reproduced in *Fig. 155*. The filling up of the temporal fossa on the side of the tumour shows in marked contrast to the hollow on the opposite side in a wasted patient, and produces an obvious alteration of contour of the face.
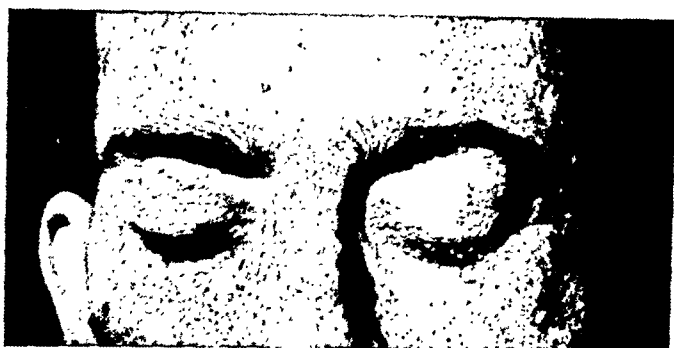
Fig. 155.—*Case 2.* Photograph of the patient J.M., showing the filling up of the temporal fossa on the side of the tumour.

There is no tendency to the formation of a mass of growth in the pharynx at the site of origin of the tumour; in fact it is the exception to see a mass of growth large enough to produce any marked nasal obstruction except in the very late stages.

II. THE STRUCTURES INVADED BY THE PRIMARY GROWTH.

This part of the study of nasopharyngeal tumours is of great interest. By virtue of their anatomical situation these tumours are capable of producing a series of very definite signs while the actual extent of the growth is very small. Also, their habit of spreading widely along submucous and subfascial planes, instead of forming a large mass in the situation of their origin, leads to an involvement of muscles of a very much more definite type than is common in other growths of the mouth and pharynx, and tends to produce a more widespread involvement of nerves, e.g., the intracranial involvement of the 6th nerve.

The structures which may be involved by the tumour may be classified as follows : (1) *Nerves* : the trigeminal nerve, the 6th nerve, the nerves of the palate, other cranial nerves. (2) *Muscles* : the internal pterygoid, the levator palati. (3) *The eustachian tube.* (4) *The cranium.*

1. INVOLVEMENT OF NERVES.

The Trigeminal Nerve.—

First Division.—Involvement of the first division of the trigeminal nerve has not occurred within my experience, and I am not aware that it has been recorded. This is not surprising, as involvement could only occur either by an extensive intracranial spread of the tumour, or by an invasion of the orbit itself, neither of which events is common.

Second Division.—Involvement of the second division is common in the early stages of the growth of the tumour. The symptom complained of is usually 'toothache', and three of the patients in my small series had had teeth extracted on account of toothache before their admission to hospital. As this symptom occurs early and is seldom or never associated with involvement of the first division, it is presumably due to an extracranial involvement of the second division. This probably takes place in the pterygopalatine fossa, a space which is accessible to the growth as it spreads forward on the base of the skull. An alternative possibility, as the pain complained of is usually in the molar teeth, is that the posterior alveolar branches of the nerve are involved as they pass over the tuberosity of the maxilla. Paræsthesia and anæsthesia in the distribution of the maxillary nerve may occur in the later stages, but its absence, even after the pain has persisted for many months, cannot be taken as evidence of absence of a growth.

Third Division.—Involvement of this division is very common, and may almost be said to be a characteristic part of the syndrome. Here again the pain is often of the character of 'toothache', for which teeth may be extracted. Sometimes, however, pain in the tongue (*Case* 1) or on the face is complained of. It is in the distribution of the third division that anæsthesia most frequently occurs. It is curious that the anæsthesia is often most definite in the distribution of the mental branch of the inferior alveolar nerve. I am unable to offer any explanation of this interesting phenomenon, and it does not seem likely that it can be in any way dependent on the confinement of the inferior alveolar nerve within its bony canal, as there is no evidence that the growth in its early stages approaches anywhere near to the canal.

Involvement of the motor division of the mandibular nerve may occur, and results in paralysis of the muscles of mastication on the side of the growth. This condition may be most easily recognized by the deviation of the point of the jaw to the paralysed side which occurs on opening the mouth. This is produced by the unopposed contraction of the external pterygoid muscle on the non-paralysed side. Palpation of the masseter on the paralysed side may be deceptive, as the rotary movement produced by the single external pterygoid turns the ramus of the jaw on a vertical axis, and this movement when felt on the paralysed side may easily be mistaken for a contraction of the masseter. Palpation of the temporal muscles provides an unmistakable physical sign.

The Sixth Nerve.—The 6th nerve is occasionally involved, usually late in the course of the disease, although in one of the cases here recorded it was the first sign of involvement of the nervous system. It is a little difficult to account for this feature of the growth, but I think most probably the nerve is attacked either directly or, more probably, by an interference with its vascular supply, in the short interval between the point at which it pierces the dura mater and that at which it enters the cavernous sinus. It lies here on the dorsum sellæ, and would be easily attacked by an upward extension of the growth either through the carotid canal or directly through the sphenoidal sinus. That extension in this direction does occur is shown by a radiogram of one of my cases (*Case* 1) in which erosion of the dorsum sellæ is seen to have taken place, and also by the post-mortem findings in *Case* 2.

The Nerves of the Palate.—A proportion of cases shows involvement of the palate other than by direct extension of the growth. The proportion in the cases here recorded is small (two in nine). but paralysis of the palate is regarded by some as one of the cardinal signs of endothelioma of the naso-pharynx *and consequently must be considered.* It has been held (Trotter[1]) that the paralysis of the palate is due to infiltration of the levator palati as a result of a direct extension of the growth. This appears to me improbable, as in this case one would expect a condition analogous to the trismus which arises from infiltration of the internal pterygoid—that is to say, a hardening and shortening of the muscle, producing a *raised* and immobile palate. This condition I have never seen, nor is it mentioned in any of the case records which I have consulted. Further, in the case in my series which showed paralysis of the palate there was also anæsthesia of the *soft palate—no amount* of manipulation of the soft palate causing the patient the slightest discomfort. In the later stages of the disease the soft palate may be rendered immobile by direct infiltration of the growth.

The association of paralysis of the soft palate with anæsthesia is difficult to explain *if one accepts in its entirety the work of Aldren Turner[2] on the* innervation of the soft palate. It is generally agreed that the sensory innervation of the soft palate is obtained from Meckel's ganglion. Previous to the work of Aldren Turner it was held that the muscles of the palate, with the exception of the tensor palati, were supplied by the facial nerve through Meckel's ganglion, *while the tensor was supplied by the motor division of* the 5th nerve through the otic ganglion. Turner's work gives good evidence that the nucleus concerned is not that of the facial nerve, but those of the vagus and accessory ; the evidence concerning the subsequent course of the fibres, however, is not so clear.

Turner's statement that " the muscles of the soft palate derive their motor supply from the pharyngeal plexus through the pharyngeal branch of the vagus " is supported only by the results of experiments on dogs and by one case recorded by Dr. Bastian,[3] in which excision of Meckel's ganglion was performed without giving rise to any palatal paralysis. More recent work by A. R. Rich[4] suggests that the tensor palati is really supplied by the 5th nerve. According to this author, paralysis of the tensor gives rise to no deformity of the palate, and can be recognized only after stripping the *mucous membrane from the muscles.* He has performed this operation on dogs and has observed paralysis of the tensor palati after section of the mandibular division of the 5th nerve. *If Rich's work is accepted,* the clinical 'paralysis of the palate' is simply a paralysis of the levator palati. As regards the origin of the nerve-supply of this muscle, he agrees with Turner in attributing it to the 11th nucleus, but again gives no convincing account of the subsequent course of the fibres.

There are several circumstances which suggest to me that the course is not through the pharyngeal branch of the vagus nerve. One of these is the coincidence of anæsthesia with paralysis of the soft palate, and another the much more frequent occurrence of paralysis of the palate than of signs pointing to involvement of the 10th and 11th nerves (cf. Woltman's table in the abstract of the literature—p. 260—in which the incidence of palatal paralysis

is exactly that of involvement of the motor division of the 5th nerve and much greater than that of involvement of the 11th nerve).

A possible course for the fibres between the 11th nucleus and the levator palati is through the jugular ganglion of the vagus and thence by the auricular nerve to the facial nerve. The further course would then be by way of the greater superficial petrosal nerve and the nerve of the pterygoid canal to Meckel's ganglion. This is a suggestion admittedly quite unsupported by experimental evidence, but it furnishes a reasonable explanation of the coincidence of anæsthesia and paralysis of the soft palate in the type of case which I am describing, and renders understandable the traditional association of paralysis of the palate with facial paralysis.

Since this article was written, Mr. Julian Taylor, of the staff of University College Hospital, has very kindly drawn my attention to a case which came under his care a short time ago and which appears to have an important bearing on the question of the course of motor nerves to the soft palate. The case history was as follows :—

A man, age 26, was admitted to hospital fourteen weeks after a motor-cycle accident. At the time of the accident there had been definite concussion, with retrograde amnesia, and, according to the statement of the patient, bleeding from the right ear and the throat. There was also swelling of the right eye. On admission the patient showed the following nerve lesions, all of which were on the right side.

Second Nerve.—Complete loss of sight in the right eye, with loss of direct (not consensual) pupillary reaction.

Fifth Nerve.—Motor : Paralysis of the muscles of mastication. Sensory : Diminution of sensory acuity and parasthesia in the distribution of the second and third divisions.

Chorda Tympani.—Perception of taste on right half of tongue delayed and incomplete ; ordinary sensation over tongue normal.

Palatal Nerves.—" When the palate is raised the uvula is seen to be displaced upwards and to the left with flattening of the right half of the arch."

The rest of the cranial nerves showed no impairment of function. In the radiogram a crack could be seen in the right parietal bone.

Here, then, is a patient who has certainly had a fracture in the middle fossa of the skull on the right side. There is no evidence whatsoever of any lesion in the posterior fossa. He shows among the cranial nerve lesions a paralysis of the soft palate, apparently of the levator palati—I say this because in a very full and accurate description of the case there is no mention of deformity of the palate at rest. It is almost inconceivable that the lesion of the palatal nerves can have occurred at any other place than in relation to the base of the middle fossa of the skull. A study of the anatomy of the middle fossa of the skull shows that the hiatus of the facial canal (from which issues the greater superficial petrosal nerve) lies immediately above the inner end of the petrotympanic fissure (through which the chorda tympani leaves the skull), and that both are in close relation on their inner side to the motor division and second and third sensory divisions of the 5th nerve.

I regard this case as evidence in favour of the view that the motor nerve supply of the levator palati is carried by the greater superficial petrosal nerve, and as showing practically beyond doubt that, whatever may be the exact course of the fibres, they are in relation to some part of the middle fossa of the skull and not derived " from the pharyngeal plexus through the pharyngeal branch of the vagus."

Other Cranial Nerves.—Reference to the review of the literature at the end of this article will show that there is no cranial nerve which has not been observed to be involved in the extension of a malignant nasopharyngeal

growth. This observation is not of any value for my present purpose, owing to the fact that in these records the various types of nasopharyngeal tumour are not well distinguished. It is clear that in the terminal stages of the endothelioma there may be extension of the growth so as to invade the nerves of the jugular foramen. This was present in one of my cases, roughly nine months after the onset of the disease, which in this case ran a particularly rapid course. Paralysis of the sympathetic on the side of the tumour was also present, although there were no palpable glands in the neck. The unfortunate patient was in a truly pitiable condition, being unable to hear owing to involvement of the Eustachian tubes, and unable to speak or swallow from paralysis of the muscles of the larynx and pharynx. In this case paralysis of the pharyngeal muscles was responsible ultimately for the death of the patient from inanition.

It is also beyond doubt that an intracranial spread of the tumour, without being extensive, can involve other nerves in the anterior part of the middle fossa. In this way the 2nd, 3rd, and 4th cranial nerves may be involved, but such an event is not common. It has occurred once only in my own experience, and this at a very late stage. However, in view of the occasional early involvement of the 6th nerve, which I believe is due to a direct invasion either of the nerve or of its blood-supply in the immediate neighbourhood, it is not impossible that cases may arise in which the spread of the growth occurs in such a manner as to lead to the early involvement of the 2nd, 3rd, and 4th nerves.

2. INVASION OF MUSCLES.

The Internal Pterygoid.—This muscle may be infiltrated directly by the growth. When this involvement occurs it leads to trismus of a greater or less degree. Trismus does not necessarily occur even in the late stages of the disease, and as far as my own cases are concerned its presence was only observed in three. On the other hand, in *Case 2* trismus was the earliest sign referable to the growth as distinguished from its metastases.

The Levator Palati.—I have already stated my reasons for believing that direct involvement of this muscle is rare. None of my cases showed the physical signs which one would expect if this muscle were infiltrated by growth. It is, however, recorded by Trotter.

3. INVOLVEMENT OF THE EUSTACHIAN TUBE.

The growth originates close to the pharyngeal opening of the Eustachian tube, and commonly causes, sooner or later, an obstruction of the lumen of the tube. This leads first to deafness on the side affected, and sometimes later to an otitis media. Unilateral deafness is a very characteristic early sign of the disease. It is only recorded in four of my cases, but I think this gives a false impression of its frequency, as it is a sign which may easily be overlooked when the patient has other more prominent signs. There is, however, one recorded case in which deafness was looked for and found to be absent.

Otitis media may result from continued obstruction to the Eustachian

tube. It was present in the later stages of one of my own cases, and was observed in one of Trotter's cases in which the growth recurred after removal. It is also mentioned by New.[5]

4. INVASION OF THE CRANIAL CAVITY.

This has been recorded fairly frequently. Involvement of the 6th nerve is, as has already been stated, probably due to an intracranial extension of the growth; also the radiogram of the skull in one of my own cases showed erosion of the dorsum sellæ. Gross clinical evidence of intracranial invasion is not, however, common. Reverchon[6] refers to it and to relief of the accompanying symptoms by lumbar puncture and subtemporal decompression. New refers to the possibility of an intracranial extension of one of these tumours being mistaken for a primary endothelioma of the Gasserian ganglion. This mistake has apparently occurred when the ganglion has been exposed for a supposed 'major neuralgia' of the 5th nerve. The error does not appear to be a likely one, as the clinical signs concerned with the 5th nerve in true 'trigeminal neuralgia' are very different from those which are seen in endothelioma of the nasopharynx. Intracranial extension does occur, and should be considered in estimating the suitability of any particular case for treatment; but none of the cases I have seen, even in their terminal stages, showed any gross clinical sign of intracranial involvement beyond the paralysis of cranial nerves. *Case* 1, when seen shortly before his death, had no headache and no sign of intracranial extension, although the radiogram taken five months previously showed erosion of the dorsum sellæ. Post-mortem evidence is regrettably scarce, but in the few available records intracranial extension is frequently mentioned. Probably before death most of these tumours do invade the cranial cavity, but it must be emphasized that the signs of a cerebral tumour or even of increased intracranial pressure have no place in the clinical picture of the cases with which I am dealing. I mention this particularly as there is a tendency among the French authors to speak of these growths as if intracranial invasion were an early and prominent feature, whereas in the experience of others, although the intracranial invasion may take place early, it gives rise to physical signs either very late or never.

III. THE CLINICAL CHARACTERISTICS OF THE GLANDS INVADED BY SECONDARY DEPOSITS.

This part of the study of these tumours is both interesting and important to the clinician. As Trotter has pointed out, the type of glandular enlargement is highly characteristic, so much so that to one who is familiar with the condition the discovery of glands of this type in a young person is sufficient to suggest the site of the primary growth. The importance of being able to recognize these glands lies in the fact that glandular enlargement may occur before the primary growth has given rise to any gross physical signs.

The glands involved are those of the upper deep cervical group, and frequently invasion on both sides of the neck is simultaneous, or practically so. The site of the earliest invasion is, unfortunately, not characteristic;

commonly the largest glands, and presumably the earliest affected, are those lying on the jugular vein behind the angle of the jaw. From here the invasion extends to affect the whole deep cervical group, and ultimately sometimes the glands of the posterior triangle. Invasion of the retropharyngeal glands appears to be rare ; none of my cases showed any sign suggesting such an invasion, neither is it mentioned in any operation notes or post-mortem record which I have consulted. Neither has invasion of the glands in the parotid region occurred in my experience, nor apparently in that of other writers on the subject. Consequently the distribution of the glands invaded is different from that found in malignant disease in other parts of the pharynx and mouth only in that the invasion is commonly bilateral in the early stages and may occur before the primary growth has given rise to any symptoms. Such a combination of signs in a young patient may easily lead to a diagnosis of tuberculous disease or lymphadenoma.

It is accordingly necessary to lay some stress on the character of the enlargement, which is, in my opinion, more helpful than the distribution. The glands are extremely hard, and very early become fixed to surrounding structures. Yet at the same time they remain distinct from one another, and the fixity is rather of the type produced by a widespread inflammatory reaction outside the capsule of the gland than of growth extending through the capsule. The impression produced on the examining hand is that of a number of hard glands fixed together by a softer fibrous mass. The glands are frequently tender to palpation to a greater degree than carcinomatous glands at the same stage of involvement.

In Trotter's paper the clinical appearance of the glands is compared with that produced by tuberculous disease, and, apart from the fact that the endotheliomatous glands are originally harder and have no tendency towards breaking down, the comparison is excellent.

IV. REMOTE METASTASES.

Conclusions on this subject are only justifiable if one has at one's disposal the records of a large number of cases observed up to their conclusion and with post-mortem records. A few cases of malignant nasopharyngeal growths showing remote metastases are recorded in the literature of the subject,[7, 11, 12] but none of these cases, so far as I can judge, belonged to the endothelioma group. In my own series two cases showed evidence of remote metastases. One patient (*Case* 4) had, when last seen, eighteen months after the onset of the disease, a large mass in the liver, the mass having appeared within the space of a few months. The other patient (*Case* 2), when seen fourteen months after the onset, was suffering with pain in the back and legs, the distribution of which strongly suggested the presence of pressure on the spinal nerve roots in the lumbar region. The radiogram of the spine showed no definite evidence of growth and no collapse of the vertebræ, but I have very little doubt that a secondary growth was present.*

These two examples of secondary growths occurring in a series of five

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* Numerous general metastases were found at the post-mortem in this case.

cases, only four of which were observed in their terminal stages, suggest that the occurrence of remote metastases is fairly frequent. It does not, however, appear to be an early event in the history of the disease. It remains to be seen to what extent remote metastases would occur if the primary growth were eradicated by the use of radium.

V. THE EARLY SYMPTOMS OF THE GROWTH.

In judging the early symptoms of the growth, I have taken into consideration, in addition to the 5 cases which have come under my personal observation, 4 cases which were undoubted examples of the disease recorded in the case books of Mr. Bilton Pollard and Mr. Wilfred Trotter. Probably many more could have been found, but I have confined myself, in speaking of cases which have not come under my personal observation, to those which were undoubted examples of the condition in question and in which the notes are reasonably complete. Using these 9 cases, the initial symptoms were as follows : enlargement of the glands of the neck, 3 cases ; pain in the distribution of the 5th nerve, 3 cases ; deafness, 2 cases ; hæmorrhage from the pharynx, 1 case.

It is interesting to note that in all three cases which showed pain in the distribution of the 5th nerve as an original symptom, attempts had been made to relieve the pain by extraction of teeth. In two cases teeth were extracted from the upper jaw, in the third the actual teeth extracted are not mentioned.

In order to give some idea of the frequency of the various symptoms and signs which I have mentioned, I have prepared a table (*Table I*, p. 252) showing the early signs in the 9 cases which I am here considering.

VI. THE MICROSCOPIC APPEARANCES OF THE GROWTH.

This is not a matter with which I propose to deal in detail : firstly, because I do not feel competent to deal arbitrarily with a matter in which pathologists find themselves at variance ; and, secondly, because among the sections at my disposal the indifferent and poor greatly outnumber the good.

It does not appear to me to be of great importance whether the tumour is called an endothelioma or is grouped as a special form of carcinoma. The sections which I have at my disposal are derived from six of the nine cases I have quoted. All these sections both from the primary growths and from the glandular metastases show a sufficient number of points of similarity to justify their inclusion in a single group.

The growth at first sight strongly suggests a carcinoma, as it is composed of large irregular cells, mostly spheroidal, lying in groups which are separated by a considerable amount of connective tissue. Throughout the tumour there is no sign of degeneration and there are no cell nests. On closer inspection there is a very evident tendency for the cells to be arranged in relation to clear spaces which do not appear to be the result of degeneration. In some sections the spaces show as fairly large clefts, but a commoner appearance is for the cells to be arranged so as to form tubules, the diameter of which is only two or three times that of a single cell. This appearance is well shown in the microphotograph reproduced from the section of the tumour

Table I.—Frequency of the Cardinal Early Symptoms in Nine Cases of Endothelioma of the Nasopharynx.

Case	Enlargement of Cervical Glands	Pain in Distribution of 5th Nerve	Anæsthesia or Paralysis in Distribution of 5th Nerve	Swelling in Mouth*	Trismus	Hæmorrhage from Nose or Pharynx	Palatal Paralysis	Unilateral Deafness	Time since Onset	Notes
1. F. G. Surgical Unit 1928	No	Yes Teeth extracted	Yes	No	Slight	Yes	Yes	Yes	3 months	—
2. J. M. Surgical Unit 1928	Yes	Yes	No	No	Yes	No	No	No	3 to 4 months	—
3. E. W. Mr. Williams 1925 and 1926	Yes	No	No	No	No	No	No	Yes	4 months	Notes state that palate was 'bulged down'
4. A. R. Mr. E. K. Martin 1926	No	Yes Teeth extracted	No	Yes	No	Yes	No	No.	15 months	—
5. H. B. Surgical Unit 1924	No	Yes Teeth extracted	No	Yes	No	No	No	No	6 weeks (probably more)	—
6. C. Mr. Trotter 1919	Yes	Yes	Paræsthesia	No	No	Yes	Yes	Yes	5 months	—
7. P. Mr. Pollard 1913	Yes	No	No	No	No	No	No	No	3 to 4 months	Notes state that palate was 'bulged'
8. J. Mr. Trotter 1911	No	No	No	No	No	Yes	No	No	5 months	Notes incomplete
9. B. Mr. Trotter 1912	Yes	Yes	No	No	Yes	No	No	Yes	2½ years	Discharge from ear
Total of Positive Cases	5	6	1	2	3	4	2	4		

* By swelling in the mouth I mean a swelling below the level of the palate which can be seen without post-nasal examination.
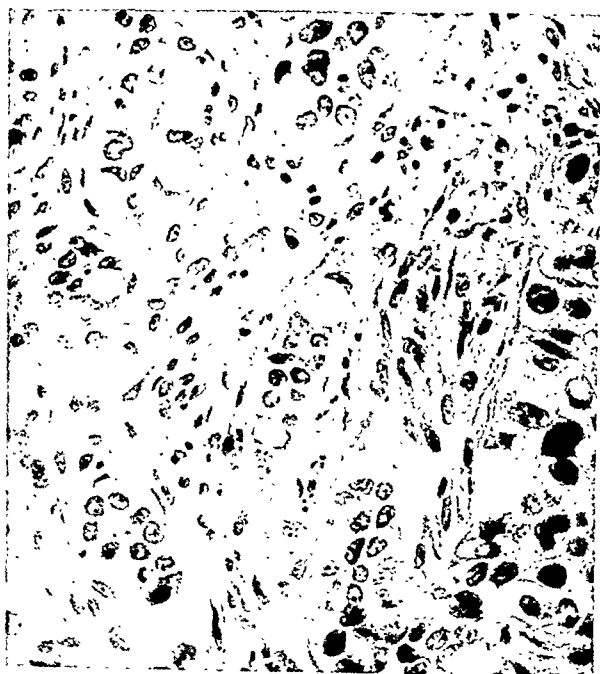
FIG. 156.—*Case 5.* The tubular arrangement of the cells is well seen, particularly in the centre of the figure, where a curved tubule has been divided transversely at both ends, the intermediate part of the section running through the wall of the tubule. ($\frac{1}{7}$ obj.)

FIG. 157.—Showing the general structure of the tumour and its tendency to submucous spread. ($\frac{2}{3}$ obj.)

taken from *Case 5* (*Fig.* 156). The section here has run through the curved part of a u-shaped tubule, dividing the tubule more or less transversely at both ends and running through its wall in the intermediate part. The arrangement is by no means as regular as this in all the sections or in all parts of the same section. In many places the shape of the cells can be seen to be adapted to the formation of a regular lumen. Another striking feature of the growth, which is in accord with its clinical behaviour, is that, however close the tumour substance approaches to the mucous membrane, it has no effect on it apart from what appears to be a pressure atrophy over the most prominent part of the growth. This peculiarity is well shown in *Fig.* 157, where the epithelium of the mucous membrane can be seen to be thinned by pressure to a marked degree without being actually invaded.

I am hopeful that in course of time, as these tumours become better recognized, it will be possible to discover the exact point of origin of the growth, and possibly in the hands of an expert pathologist the peculiar microscopic structure might furnish some clue.

VII. POSSIBLE LINES OF TREATMENT.

A very cursory consideration of the physical signs of these tumours will be sufficient to convince the majority of surgeons of the futility of ordinary surgical methods as a means of treatment. Trotter has obtained a temporary success in one of his cases, the patient being free from recurrence for eighteen months. Considering the manner in which these tumours spread, and the situation in which they originate, such a result is sufficiently gratifying, but it cannot be said to be satisfactory. The only case in my own series in which the question of operability arose was *Case* 1, and in view of the fact that both the second and third divisions of the 5th nerve were involved it was not considered that an attempt at radical removal could be justified.

The question of treatment by radium has yet to be considered. *Cases* 2 and 3 of my series were treated with radium for the enlarged cervical glands, in both cases with some measure of success; *Case 3* is at the time of writing still under my observation, and the glands have progressed but little since the time at which I first saw him some nine months ago. The only cases in which a direct application of radium to the growth was tried are *Cases* 4 and 5, where little or no improvement followed. Here the growth had extended very widely before any treatment was attempted, and the irradiated part of the tumour can only have been the outlying margin of a very extensive mass. However, the fact that the glands can be kept in check by radium seems to show that radium has some influence on the tumour. The only line of treatment which appears to me to offer any hope at present is the insertion of seedling tubes of radium emanation in the directions in which we know the tumour to spread. This can, I think, be done only by exposing the tumour by means of Trotter's osteoplastic resection of the upper jaw; I have made one attempt at inserting radium without exposing the tumour, and was impressed by the obvious futility of the proceeding.

The outlook from the point of view of treatment is distinctly gloomy, but I should not now hesitate to use seedling radon tubes after exposing the

growth. As a purely palliative measure where the pain is severe an alcohol injection of the Gasserian ganglion may be tried. In the only case where I have done this there was a definite but transient relief.

CASE RECORDS.

The cases here recorded are those which have come under my personal observation. That the clinical observations in the earlier cases are not more complete is due to the fact that I did not at the time realize that they belonged to this group and consequently did not look for signs such as unilateral deafness. There is, however, in my opinion, sufficient evidence to justify grouping these five cases together as examples of endothelioma of the nasopharynx in its different stages and different aspects.

Case 1.—(Surgical Unit 4955, 1928). F. G., a man of 56, was admitted with a three months' history of pain in the left side of the face extending from the eye to the lower border of the mandible. Carious teeth had been removed without influencing the pain. During the three months the patient had noticed the onset of deafness on the left side and difficulty in opening his mouth. For one month there had been an occasional burning sensation on the left side of the tongue. A few days before admission he had a profuse hæmorrhage from his nose and mouth.

PHYSICAL SIGNS—A strong healthy-looking man. The speech suggested obstruction of the nose. There was pain in distribution of second and third divisions of the 5th nerve on left side ; paræsthesia and numbness in the distribution of the second division ; anæsthesia over area supplied by mental branch ; paralysis of muscles of mastication on left side. The soft palate was insensitive and immobile on left side, and there was deafness in the left ear. A hard sessile mass was palpable on the left lateral wall of the nasopharynx ; it extended down to the tonsil, and was not ulcerated. The X-ray showed erosion of the dorsum sellæ. There was no enlargement of glands in neck. No treatment was attempted.

FURTHER PROGRESS.—This was rapid, and five months after admission the patient was moribund from inanition following on paralysis of the pharyngeal muscles. There was also paralysis of the larynx, and the left sympathetic was involved. There were no obvious secondary deposits, no enlarged glands, and no signs of intracranial involvement.

REMARKS.—This case may be taken as typical of the condition, apart from the absence of glandular involvement.

Case 2.—(Surgical Unit 4808 and 4939, 1928). J. M., a man of 29, had had swelling in left side of neck for three or four months, stiffness of the jaw for five or six weeks, aching pain in gums of left side for two weeks.

ON EXAMINATION.—He was fairly well nourished. There was marked trismus. Typical 'endotheliomatous' glands were noted in the left deep cervical group and one large gland on right side. No anæsthesia in distribution of the 5th nerve. X rays showed a wisdom tooth lying horizontally in the lower jaw on the left side. The nasopharynx was not examined, owing to trismus.

TREATMENT.—The wisdom tooth was removed, and a gland excised for section. Subsequently numerous applications of radium were made to the glands in the neck, and an alcohol injection of the Gasserian ganglion was attempted for relief of pain. This was temporarily successful.

MICROSCOPIC SECTION of the gland shows a typical endothelioma.

PROGRESS.—Nine months after the onset a firm submucous swelling appeared at the junction of the hard and soft palate on the left side. A month later a mass appeared filling up the left temporal fossa (*see Fig.* 155). There was then a left external rectus palsy and anæsthesia over the distribution of the mental branch of the trigeminal. The patient complained of a discharge from the left ear and

deafness. No palatal paralysis. The glands had increased somewhat in size, but were kept in check by applications of radium. His general nourishment remained good.

Five months later, and fourteen months after the onset of the disease, this patient was readmitted in a very wasted condition. The 6th-nerve paralysis had then disappeared and subsequently varied in degree from day to day, but the left pupil showed a deficient reaction to light and accommodation, presumably as a result of a partial paralysis of the 3rd nerve. The patient also complained of dimness of vision in the left eye, and this eye subsequently became almost blind. There was nothing to suggest the presence of growth in the orbit, and on examination of the optic disc there was no optic neuritis. There was some difficulty in swallowing, which appeared to be due neither to pain nor to mechanical obstruction. Headache was absent, and the pain in the face was still strictly limited to the left side.

The glands had increased greatly in size during the previous month, and the patient complained of pain in the lumbar spine, girdle pain, and pain in the front of the legs. There was no deformity of the spine, and X rays failed to show any definite evidence of invasion of the lumbar vertebræ.

The patient gradually became weaker, and died, about sixteen months after the onset of the disease, from pneumonia.

POST-MORTEM EXAMINATION.—Thanks to the skill of Dr. Barnard, who performed the post-mortem examination and removed the specimen, I was able to examine the relation of the growth to the base of the skull in some detail. The specimen as it came to me consisted of a large portion of the central part of the base of the skull, together with the maxillæ and nasal cavities, the pharynx, tongue, larynx, and the great vessels of the neck.

From this specimen I removed the basiocciput, and the body and small wings of the sphenoid bone. The bone here showed no sign of invasion by growth, and both the sphenoidal sinus and the pituitary fossa were free from involvement. The remaining portions of the great wing of the sphenoid were removed piecemeal to permit of tracing the branches of the 5th nerve into the growth. The growth was firmly attached to the bone in the neighbourhood of the foramen ovale, and the bone here appeared to have been eroded. The microscopic section of the bone, however, showed no actual invasion by growth. The specimen was then bisected in a sagittal plane, leaving the inner end of the petrous part of the temporal bone in situ on both sides.

On examining the specimen from inside the pharynx there is no ulceration of the mucous membrane. The left Eustachian orifice is obscured by a submucous swelling, and the whole lumen of the nasopharynx on the left side is diminished, although the pharynx is held permanently open by the rigidity of its walls on the left side, giving the lumen, in cross-section, a wedge-shaped appearance with the base of the wedge to the left. Examination of the divided wall of the pharynx shows that its roof is infiltrated with growth, as also is the soft palate. The growth has not extended forward so as to obstruct the nasal choanæ.

Examination from outside shows a mass of growth on the left lateral wall of the pharynx, continuous below with a glandular mass which surrounds the great vessels of the neck. The mass occupies the pterygoid region and, extending forward, has completely filled the maxillary antrum, encircling and destroying the pterygoid plates and the posterior wall of the antrum. The growth partially encircles the ramus of the lower jaw.

On the roof of the pharynx, in the situation from which the basisphenoid has been removed, is a mass of growth more than a centimetre in thickness in its hardened state. It extends across the middle line as far as the right foramen ovale.

The sole intracranial spread of the tumour is by way of the carotid canal. On the left side the carotid artery is embedded in a process of the growth which extends up into the interior of the skull, but apparently stops short of the cavernous sinus. The left 6th nerve as it passes over the lip of the petrous temporal enters this process of growth. The same process of growth turns outwards over the petrous

temporal and runs beneath the Gasserian ganglion. The first and second divisions of the 5th nerve pass forward without being obviously involved in the growth, but the third division passes downwards through the foramen ovale into a mass of growth outside the skull.

The 4th and 3rd nerves can be traced in the cavernous sinus and are apparently free from growth, although they are less easy to trace than on the right side. There is no macroscopic involvement of the optic nerve.

The carotid artery is not thrombosed. The whole extent of the intracranial growth is not greater than that of the Gasserian ganglion. On the right side the growth has invaded the lower end of the carotid canal, but has not reached the interior of the skull and has not involved the 6th nerve.

Metastases having the same macroscopic appearance as the primary growth were found in several ribs, in the spine, and in the left lobe of the liver.

The macroscopic evidence suggests that the 6th nerve and the third and second divisions of the 5th nerve were involved directly in the growth. The cause of the disturbance of the function of the oculomotor and optic nerves is less obvious, but was in all probability an interference with their blood-supply. In the earlier stages this was probably true also of the 6th nerve, as the loss of function was temporary at first and tended to vary in degree for some time.

Microscopic sections were made of the optic nerve proximal to the orbit, and of the 3rd nerve and the first and second divisions of the 5th in the cavernous sinus. The optic nerve showed no invasion by growth and was not degenerated at the point where the section was made ; hence the involvement was probably posterior to the section, i.e., intracranial and not intra-orbital. The sections of the 3rd nerve and the first and second divisions of the 5th, taken from these nerves in the cavernous sinus, showed no growth.

The post-mortem is interesting mainly in showing the small extent of the intra-cranial spread in relation to the size of the extracranial mass, and in demonstrating that clinical signs of interference with the function of the nerves running in the cavernous sinus may be present before the growth has actually reached the nerves in question.

REMARKS.—The nasopharynx was never examined in this case owing to the trismus. The symptoms and the microscopic appearances, in association with the appearance of the swelling in the mouth, left no doubt as to the nature of the tumour. Radium was temporarily successful in keeping the progress in the glands in check.

Case 3.—(Mr. Gwynne Williams, 4611, 1925, and 834, 1926.) E. W., a woman of 44, had complained of lumps in the left side of the neck for four months, and similar lumps on the right side for one month. Previous to this she had become deaf in the left ear.

ON EXAMINATION.—She was fairly well nourished. There were typical 'endo-theliomatous' glands on both sides of the neck, and by the mouth was a hard mass which bulged down the soft palate and could be felt on the left lateral wall of the nasopharynx. She had no pain except on palpation of the glands.

MICROSCOPIC SECTION OF TUMOUR.—Endothelioma.

TREATMENT.—Radium was inserted into the glands and the primary tumour.

PROGRESS.—The glands diminished in size. Two months after the first applica-tion an external rectus palsy appeared on the left side. A further application of radium was made to the glands. The patient was not seen again.

REMARKS.—These tumours are unusual in women. The absence of pain is a remarkable feature. On her second admission the patient complained of loss of voice, which may have been due to a commencing laryngeal paralysis.

Case 4.—(Mr. E. K. Martin, 2936 and 3855, 1928.) A. R., male, age 58, fifteen months previous to admission had a copious hæmorrhage from his mouth which lasted for one night. Previous to this he had had 'toothache' for which some teeth had been extracted. He was then fairly well for a year, after which a recurrence of the toothache was followed by a further hæmorrhage.

PHYSICAL SIGNS.—A pale but well-nourished man. There is a firm submucous swelling extending forward from the junction of the hard and soft palate to the incisor region. The palatal swelling is more marked on the left side, and there is a visible swelling of the face over the left maxilla. There are no enlarged glands in the neck. There is some nasal obstruction, which the patient believes to be more marked on the left side.

MICROSCOPIC SECTION OF TUMOUR.—Endothelioma.

TREATMENT.—Radium was applied to the accessible parts of the tumour without producing any marked improvement.

PROGRESS.—Three months later the patient was readmitted. He was then obviously wasted. The tumour had increased in size by a further submucous extension, so that the upper jaw and alveolus on both sides were enormously enlarged. There was an ulcer at the junction of the hard and soft palate on the left side. There was a large mass in the liver. A further application of radium produced no beneficial result.

REMARKS.—There is perhaps some doubt as to whether this case is rightly included in the series. There was, however, a long period between the onset of symptoms referable to the presence of a tumour and the appearance of the tumour in the mouth. When the growth did appear it was in the typical situation and showed the typical submucous spread. Microscopically it coincided with those of the other cases in the series. In combination with the presence of 'toothache' as an original symptom, these facts appear to me to mark this case as an endothelioma of the nasopharynx.

Case 5.—(Surgical Unit 2590 and 2710, 1924.) H. B., a man of 59, was admitted complaining of pain in the right upper and lower jaw, following extraction of carious teeth, and swelling of the face. The teeth had been removed six weeks before admission. He was a thin man. There was a visible swelling of the right side of the face. A week later a submucous swelling appeared at the junction of the hard and soft palate on the right side. Six weeks later there was a large swelling in the mouth on the right side, extending over the alveolus. The mass was superficially ulcerated. The palate on the right side was pushed down and immobile, and the uvula was pushed over to the left. The right temporal fossa was filled up by a mass beneath the deep fascia, producing an obvious deformity of the face. There were no enlarged glands in the neck.

MICROSCOPIC SECTION.—Endothelioma (*see Fig.* 156).

TREATMENT.—Radium was inserted into the accessible part of the tumour. This produced a very temporary improvement, and the patient was shortly afterwards transferred to an infirmary.

REMARKS.—I think there can be no doubt that this case belongs to the group of tumours in question. The onset with pain in the distribution of the 5th nerve, the site of appearance and submucous character of the tumour in the mouth, and the microscopic appearance of the tumour, are sufficient to justify its inclusion. In addition to these points, the extension of the tumour into the temporal fossa took place in exactly the same manner as that in *Case 2*. There are no observations as to deafness and anæsthesia in the distribution of the 5th nerve, as I saw the case before I was familiar with the numerous and diverse manifestations of these tumours, and did not at the time realize that this case belonged to the group.

LITERATURE OF THE SUBJECT.

For several reasons I have thought it advisable to devote a separate section of this article to a review of the literature of the subject. Reports of malignant tumours of the nasopharynx showing involvement of the nervous system are fairly numerous, but as a result of the diversity of the symptoms, cases have been reported by neurologists, laryngologists, pathologists, and ophthalmologists, and naturally each specialist has tended to dwell on the

aspects of the case most interesting to himself. It is clear that many of the reported cases belong to the group which I have attempted to describe, but often examples of other forms of tumour are included under the same heading. A further difficulty is introduced by the fact that there is no uniformity of opinion as to the interpretation of the microscopic appearances of the endothelioma, and it is usually impossible to gather from the reports of microscopic examination whether or not a particular reported case belongs to this group. In a few cases clinical peculiarities of the tumour sufficient to place it are mentioned, but more often one finds the unadorned statement that a tumour was present in the nasopharynx.

The term 'endothelioma' is admittedly more or less properly applied to 'mixed' or 'salivary' tumours, and some reported cases of endotheliomata in the pharyngeal region are clearly examples of these tumours, which are met with fairly frequently in the palate.[8] They possess no points in common with the endothelioma of the nasopharynx beyond their somewhat unfortunate name.

The earliest reference which I have consulted is a long article published in 1907 by Harmer and Glas.[9] This article is concerned mainly with tumours originating within the nasal cavity, sometimes invading the cranial cavity through the cribriform plate, and the orbit in the neighbourhood of the lamina papyracea. These tumours are naturally liable to be associated with invasion of the first four cranial nerves, and may also give rise to neuralgic pain. The pain, however, is often in the distribution of the first division of the trigeminal nerve, sometimes in that of the second division, and (as far as I am able to judge from the literature) never in that of the third. Moreover, tumours of this type are liable to be associated quite early in their course with proptosis, which is due to actual filling up of the orbit with growth, and with definite symptoms pointing to a nasal origin, such as epistaxis and nasal obstruction. The pain appears to be due in many cases to obstruction of the outlet of the frontal sinus or the maxillary antrum, and suppuration may arise in these cavities from the same cause. Naturally these tumours do not often come under the care of a general surgeon, and, consequently, my knowledge of them is gathered almost entirely from the literature of the subject. It appears certain to me that much of the difficulty which one encounters in attempting to form a clear conception of malignant tumours of the nasopharynx from lists of reported cases is due to the fact that usually no distinction is made between these growths, which are primarily tumours of the nasal cavity with a tendency to secondary involvement of the first four cranial nerves, and the group I have described, which consists of tumours which are really infiltrating growths at the base of the skull accessible to the examining finger in the nasopharynx. Perhaps the most useful distinction is the presence of proptosis in a number of cases of the intranasal type. Harmer and Glas do not classify any of the tumours in their report as endotheliomata, but there was at the time a considerable controversy in Germany as to the characteristics of an endotheliomatous tumour, and the literature of the time tends to place the incidence of the endothelioma very high or very low according to the views of the writer. However, allowing for this point, I have been unable to satisfy myself that any one of the tumours mentioned in this paper belonged to the group which I have described.

A somewhat later article by Pollak,[10] published in 1911, deals almost exclusively with the pathological side of the question, and places the incidence of endotheliomata very much higher.

In 1911, in a paper read before the Medical Society of London, Trotter[1] gave a short account of the tumours with which I am dealing, and it was this paper which first attracted the interest of the present writer to the condition.

Several papers of later date are devoted to an account of nasopharyngeal tumours which have given rise to symptoms of interference with the nervous system, still, however, without any very successful attempt to differentiate the various types. The most valuable of these papers is one published in Chicago in 1922 by H. W. Woltman.[11] In it are reported 25 cases of naso-pharyngeal tumours with involvement of the cranial nerves; 15 of these are stated to have been squamous epitheliomata and 6 lymphosarcomata. A list of the nerves which were found to be involved in these 25 cases is, I think, worth quoting fully (*Table II*).

Table II.—SHOWING THE PROPORTIONS IN WHICH THE CRANIAL NERVES WERE INVOLVED IN 25 CASES OF NASOPHARYNGEAL TUMOUR REPORTED BY H. W. WOLTMAN.

CRANIAL NERVE	EPITHELIOMATA	ALL CASES
I	Not determinable	
II	1 in 15	5 in 25
III	2 ,, 15	4 ,, 25
IV	2 ,, 15	4 ,, 25
V Sensory	6 ,, 15	11 ,, 25
V Motor	4 ,, 15	6 ,, 25
VII	1 ,, 15	1 ,, 25
VIII	Not determinable	
Palate	4 in 15	6 in 25
Vocal cords	1 ,, 15	3 ,, 25
XI Spinal	1 ,, 15	3 ,, 25
XII	4 ,, 15	5 ,, 25

In addition to the author's 25 cases a list of cases from the previous literature is given. Some of these tumours belong certainly to the group which I have described; others certainly do not. On the whole, those described as squamous epitheliomata bear a closer resemblance to my cases, and in one of these it is mentioned that in the later stages a swelling appeared in the temporal fossa, presumably of the same nature as that described in *Cases* 2 and 5 of my series.

As regards the question of remote metastases, these were present in one of this author's cases and in three of those which he has collected from the literature. None of these can be said with any certainty to belong to the endothelioma group. Other interesting points are made in this article, particularly that of the possibility of confusion of a malignant nasopharyngeal tumour showing X-ray evidence of destruction of the sella turcica with a pituitary tumour; and that of the varying degree to which the sensations of pain,

touch, and temperature are lost when the 5th nerve is involved in the growth of the tumour.

New,[5] dealing also with the recent cases from the Mayo Clinic, emphasizes the frequency with which patients suffering from malignant nasopharyngeal tumours are submitted to operations such as extraction of teeth or tonsils, in the hope of relieving pain the true cause of which has not been diagnosed.

Crow and Baylor[12] are concerned less with the neurological aspects of the cases than with the treatment by radium. In their article the cases grouped as carcinoma include many which correspond closely to those which I have described. Over one-third of these cases had signs of gross intracranial invasion before death, 13 of 15 had glandular involvement, and 9 had marked trismus. The earliest symptom was pain in the ear or loss of hearing in 7 cases, and glandular enlargement in 3. On the whole, the patients are younger than those of my series, the average age of the 15 cases being about 32. Paralysis of the palate is mentioned in several instances. Radium was used sometimes in the treatment of patients in this group, but no cures are recorded, although a temporary improvement was occasionally produced.

Two interesting cases are excellently reported from the point of view of the ophthalmologist by Stähli, of Zurich.[13] The first of these showed a 6th-nerve palsy as the sole symptom of the condition for a period as long as five months; the second was first seen complaining of a 3rd-nerve palsy. It is possible that the second case was an example of the intranasal type of growth rather than the infiltrating endothelioma. This author has noted the very interesting point that in both these cases the degree of paralysis after the onset was inconstant, and even complete recovery took place for short periods.

There remains to be considered the modern French literature on the subject.

M. Jacod, of Lyons,[14] recognizes the type of growth which I have described, and speaks of it as a 'peritubular sarcoma'. He has devoted much attention to the intracranial spread of these tumours, which he believes to take place through the bony part of the Eustachian tube, whence it is directed forwards into the middle fossa of the skull, rather than backward into the posterior fossa, by reason of the relative thickness of the bone in these two directions. According to Jacod the cranial nerves are involved within the skull at a point which he speaks of as the 'carrefour pétrosphénoïdal—that is, the situation at which the antero-internal end of the petrous temporal comes into contact with the great wing of the sphenoid. Here the first six cranial nerves are placed in close apposition to one another, and may be involved by a comparatively small growth. M. Jacod states that in the peritubular sarcoma the first six cranial nerves are invariably attacked sooner or later, while those which leave the skull in the posterior fossa are never involved. Paralysis of the sympathetic has been noted by him, and he holds that invasion of this nerve occurs in the cavernous sinus.

In my own experience, and in the experience of other authors whose work I have quoted, the nervous signs are by no means as regular as this, and the invasion is definitely not confined to the first six cranial nerves. Neither is invasion of the 2nd, 3rd, and 4th nerves by any means frequent. One only of my cases showed involvement of these nerves, and the proportion in the

'epitheliomata' reported by Woltman is strikingly low.   An isolated 6th-nerve paralysis produced by intracranial invasion arouses no surprise, but a prolonged and isolated involvement of one or two parts only of the 5th nerve suggests much more strongly an extracranial invasion.   One would have expected also that a growth so accurately localized at the 'carrefour pétrosphénoïdal' would, in a proportion of cases, give rise to a thrombosis of the cavernous sinus. There is no mention of this event in any of the articles which I have consulted. The invasion of the sympathetic has been held by some authors to be due to glandular metastases, but I think this theory is untenable, as in one of my own cases there was a sympathetic paralysis although no enlarged glands could be felt in the neck.   Most probably, I think, it occurs before the sympathetic comes into relation with the cavernous sinus.

In the article by M. Jacod referred to above, two cases are quoted.   I believe the same author made a previous communication on the subject in the year 1920, but this I have been unable to trace.

Reverchon[6] reports fully two cases, giving in one of them a record of the post-mortem examination.   At the post-mortem of this case a mass of growth was found covered by intact dura mater in the middle fossa behind the great wing of the sphenoid.   Growth had invaded the sphenoidal sinus, and outside the skull it occupied " all the recesses of the surrounding regions ".   The second case is mainly remarkable for the fact that in the early stages there was a transient attack of herpes zoster in the distribution of the 5th nerve on the side of the tumour.   In both these cases Reverchon refers to ' phénomènes d'hypertension ' which in the first case were relieved by lumbar puncture and in the second by a subtemporal decompression.   Treatment by radium met with some success in both cases ; indeed, it is recorded of the second that after a year of treatment the weight of the patient had increased by 5 kilo. M. Monod, of the Radium Institute, is quoted as giving the following opinion as regards treatment by radium : " Il est vain d'essayer dans un cas semblable, d'atteindre tous les prolongements par la radiopuncture.   Si le traitement par le radium est indiqué il faut avoir recours à des appareils moulés recouvrant complètement la région à irradier."   An apparatus covering practically the whole of one side of the face and temporal regions would thus be necessary, and a sufficient quantity of radium would be required to irradiate adequately the whole of this region in one application.   I speak without experience of this form of irradiation, but I believe that in the present state of our knowledge of the technique of irradiation the difficulties would be very considerable both in attaining a sufficient concentration at a situation so far from the surface and in avoiding damage to normal structures.

The opinion of M. Monod in this matter is, of course, entitled to the very greatest respect.   Nevertheless, provided that the presence of the tumour is recognized at a reasonably early period and that the region concerned is adequately exposed by a well-planned operation, I think that there are good prospects of success in treatment by implantation of radium emanation. Naturally success in treatment by implantation depends on an accurate knowledge on the part of the surgeon of the directions in which the tumour ordinarily spreads, and I hope that my article will be found of use in attaining this knowledge.

SUMMARY.

1. An account is given of the clinical characteristics of a tumour usually described as an endothelioma of the nasopharynx. The variability of the clinical picture presented by these tumours is emphasized.

2. It is suggested that tumours of this type are by no means uncommon, and that many of them pass unrecognized because of the absence of obvious symptoms pointing to a nasopharyngeal origin, and because the presence of a tumour is only recognized when the condition is sufficiently far advanced to render the primary origin of the growth a matter of conjecture, and of purely theoretical interest.

3. It is emphasized that there is some evidence to show that endotheliomata in this region react favourably to radium except when it is applied only to the outlying parts of an extensive tumour, and it is suggested that good results might be obtained by a combination of adequate exposure of the growth with irradiation by means of seedling tubes of radium implanted in the directions in which the tumour is known to extend.

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TWO CASES OF RIEDEL'S CHRONIC THYROIDITIS.

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IN view of the rarity of this condition it has been thought worth while to add two more to the number of published cases.   A. F. Bernard Shaw and R. P. Smith[1] reported on six cases, and gave a review of the literature, in the BRITISH JOURNAL OF SURGERY in 1925.   Both the following cases bear a close resemblance to the earlier ones of their series, or to what used to be termed Hashimoto's struma lymphomatosa.   As has so often happened, the diagnosis was only made microscopically, and in the first case with consider-able difficulty.

Case 1.—The patient, a woman of 46, was transferred from the medical wards with a marked enlargement of the thyroid gland involving mainly the right lobe, which was smooth and very firm in consistence.   She gave a history of a swelling in the neck of six years' duration, with a fairly rapid increase in

FIG. 158.—Case 1.   Showing two lymph follicles and acini amongst the granuloma.
(× 100.)

size during the last three months.   Her complaint was of slight dyspnœa, occasional hoarseness, and occasional palpitation, especially on exertion. She stated that she was easily tired, but her general health seemed good, although she showed signs of slight thyroid deficiency.   There was no evidence of tuberculosis, and the Wassermann reaction was negative.   The pulse-rate

was 80 per minute. The condition was thought to be a parenchymatous goitre, but the question of malignancy was considered owing to the unusual hardness of the gland.

OPERATION.—The right lobe and isthmus of the thyroid were removed with some difficulty owing to adhesions to the surrounding structures. There was some thickening of the capsule. The cut surface of the gland was finely lobulated, opaque, and solid looking, and seemed entirely devoid of colloid.

The patient was seen recently, two and a half years after operation. A definite thyroid deficiency had been counteracted by the administration of thyroid extract, and she is now feeling very well. There has been no recurrence of the swelling, and the left lobe of the thyroid has gradually decreased in size.

HISTOLOGY. — The capsule and interlobular septa are all infiltrated with mononuclear cells. The vessels are scanty and of normal thickness. The appearances in different places vary considerably. In some parts, presumably where the disease is more advanced, hyaline stroma forms a coarse reticulum enclosing comparatively few cells and no acini. Other parts show a very cellular granuloma, with a minimal amount of stroma and enormous numbers of plasma cells, lymphocytes, and a few fibroblasts. In some of these areas acini are present in considerable numbers. Some contain a small amount of colloid. Where acini are unrecog-

FIG. 159.—*Case* 1. An acinus is seen to the right of the centre containing a foreign-body giant cell and phagocytes. To the left is an acinus containing colloid which is undergoing phagocytosis. (× 200.)

nizable high-power examination sometimes reveals the remains of epithelial cells, many invaded by leucocytes or plasma cells which are apparently acting as phagocytes.

The most striking feature in all the sections examined is the presence of very definite and well-formed lymph follicles (*Fig.* 158). These vary in size, and are round or oval in shape. Each germ centre is surrounded by a definite zone of lymphocytes which varies in thickness and is limited by a delicate stroma containing capillaries. Among the cells of the follicle a considerable amount of irregular hyaline material is seen. The majority of the cells are large and round with vesicular nuclei, but lymphocytes and fibroblasts are also present. These follicles are to be found throughout the sections.

Another notable feature is the number of giant cells to be seen with a low power (*Fig.* 159). They are unevenly distributed and are not associated with the lymph follicles. With a higher power many of these are found to be masses of colloid invaded by phagocytic cells which are at times arranged in a circle. These masses are usually to be seen within acini. The most striking of the real giant cells are strongly suggestive of tubercle, and are, in our opinion, foreign-body giant cells. They are commonly embedded in degenerating acini, their cytoplasm being readily distinguishable from that of the epithelium by slight differences in texture and staining. The nuclei are smaller than those of the epithelium and they are arranged in characteristic groups. As already mentioned, the acini may also show invasion by plasma cells. In places these giant cells are actually within acini, but we could find no evidence that they were derived from the epithelium, although a multinucleate condition of the epithelial cells may occasionally be seen.

Case 2.—The patient, a woman of 34, gave a history of a swelling in the neck of five years' duration, associated for the last year with severe attacks of dyspnœa which had caused her to seek advice. The right lobe and isthmus of the thyroid were enlarged, the swelling being smooth and apparently cystic. She showed signs of slight hyperthyroidism, but the pulse-rate was only 86 per minute. The Wassermann reaction was negative.

OPERATION.—Although but slightly enlarged, the right lobe of the thyroid was removed with great difficulty owing to adhesions to surrounding structures, particularly the trachea. The cut surface of the isthmus was normal in appearance, while that of the right lobe was of an opaque white colour broken in places by vascular strands and studded with yellowish areas of colloid.

HISTOLOGY.—There is much thickening and cellular infiltration of the capsule and interlobular septa and some sclerosis of the blood-vessels. The typical granuloma with large numbers of lymph follicles and very marked fibrosis composes most of the gland, but, in striking contrast to the first case, there are areas of comparatively normal acini. Some contain colloid and others show absorption of colloid and definite signs of activity. Here also masses of colloid can be seen invaded by phagocytic cells, but the foreign-body giant cells are very scanty.

Both these cases appear to be examples of Riedel's chronic thyroiditis. Histologically the lesion in the first is at an earlier stage. Although the gland parenchyma is much more extensively destroyed, the granuloma is more cellular and there is less fibrosis than in the second case.

While differing in our interpretation of the giant cells, we agree with Bernard Shaw and Smith that the lymph follicles represent hyperplasia of the minute lymphatic nodes to be found in so many organs, and that the true nature of the condition is that of a non-tuberculous granuloma.

I have to thank Mr. Kay, Mr. Milne McIntyre, and Professor John H. Teacher for permission to publish, and Professor Teacher for the photographs and for much helpful criticism.

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REPORT OF A CASE OF ANEURYSM OF THE SPLENIC ARTERY:

WITH REFERENCES TO 58 CASES COLLECTED BY THE AUTHORS.

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ANEURYSMS of the branches of the abdominal aorta have been looked upon as pathological rarities, but there have been so many instances recorded recently that their recognition as a cause of clinical symptoms becomes of increasing importance. In 1928 Thomson[1] was able to collect 65 cases of aneurysm of the hepatic artery, and Senger[2] 40 cases of aneurysm of the renal artery. We have been able to find in the literature 58 cases of aneurysm of the splenic artery.

CASE REPORT.

Mrs. M., age 49, was admitted on Dec. 17, 1926, at 11 p.m., suffering from agonizing pain in the abdomen of seven hours' duration.

PREVIOUS HISTORY.—The patient was too ill to give a detailed history, but her husband said that for some years she had suffered from 'indigestion' —pain and discomfort coming on three to three and a half hours after meals, and occasional sickness and vomiting. There was no history of hæmatemesis or of melæna. She was indefinite about her menstrual history—thought the last period was two weeks ago, but stated that for some time there had been irregularity.

PRESENT ILLNESS.—About 4 p.m. on the day of admission the pain came on suddenly, and she collapsed but did not become unconscious. She vomited a little, but did not notice the nature of the vomitus. The agonizing pain continued till the time of her admission.

ON EXAMINATION.—Patient was anæmic and collapsed; temperature 98°, pulse 126, respirations 24. The abdomen was somewhat distended, tender all over, but with no muscular rigidity. Liver dullness was present, and ? dullness in both flanks. Pelvic examination was negative. No gross lesion of heart and lungs was made out. The provisional diagnosis was intraperitoneal hæmorrhage ; ? ectopic gestation.

Operation (W. A.).—A right paracentral incision was made. A large quantity of fluid blood escaped from the peritoneal cavity, and a few soft blood-clots were removed from the pelvis. Examination of the pelvic organs showed the uterus to be slightly larger than normal, and the extremity of

the left Fallopian tube to be somewhat patulous. A rapid examination of the rest of the abdomen did not reveal any gross abnormality. Thinking I was dealing with a left tubal abortion I quickly removed the outer half of the tube and closed the abdomen. A pint of normal saline was given intravenously.

Convalescence was somewhat stormy for five days, the temperature being as high as 102° the day following operation, but thereafter the patient did well and was almost ready to leave hospital. On Jan. 4 she was reading in bed when she asked for a bed-pan ; before it could be brought she collapsed and died within twenty minutes. The symptoms suggested a pulmonary embolism.

Professor Low, Anatomy Department, Aberdeen University, kindly undertook the examination of the Fallopian tube, but careful serial section study failed to reveal any evidence of pregnancy.

Post-mortem Examination (J. G.).—The body was very pale. The greater sac of the peritoneal cavity contained a large amount of blood-clot and fluid blood of evidently recent origin. The lesser sac also was distended with blood. Some of this was fluid blood or recent clot similar to that in the greater sac, but there was a thick, shaggy layer of older clot adherent to the wall of the lesser sac throughout. At one point on the posterior wall there was an irregularly rounded crater-like depression in this layer of older clot, and that point was found to lie immediately over a saccular aneurysm of the splenic artery. A small chink-like opening in the wall of the aneurysm communicated with the lesser sac at this site. It was evident that two hæmorrhages had occurred from the aneurysm at different dates.

The first hæmorrhage, which, from the history, had evidently immediately preceded the operation, marked the time of the initial rupture of the aneurysm into the lesser sac. Hæmorrhage had at that time extended from the lesser sac through the foramen of Winslow into the greater sac, and accounted for the blood found there at operation. Such of the blood in the greater sac as had not been removed at operation was apparently absorbed subsequently. Much of the blood in the lesser sac had, however, remained, and formed the older, more adherent clot just described there. This clotting temporarily closed the opening in the aneurysmal wall.

The second and fatal hæmorrhage, occurring eighteen days after, burst through the same opening in the aneurysm into the lesser sac, ploughing up the older clot on the wall of the sac and passing by way of the foramen of Winslow to the greater sac.

The aneurysm itself was a 'false' aneurysm, a rather rough-walled sac forming a more or less rounded cavity about the size of a cherry lying in the substance of the pancreas. It opened from the main splenic artery by a narrow gap about half an inch long on the antero-inferior aspect of that artery at a point just outside the hilus of the spleen.

To the naked eye there was no atheroma of the splenic artery or of the main trunk of the cœliac axis. There was a small amount of blood-clot around the pancreas. The uterus and the uterine appendages on the right side were healthy. Beyond marked anæmia there were no important alterations in other organs.

Microscopic Examination.—

Splenic Artery Proximal to the Site of the Aneurysm.—The outer half of the media appeared to be almost normal. The inner half, however, showed extensive partial necrosis of the muscle fibres, the muscle nuclei being broken up or greatly distorted where they had not actually disappeared. A rather surprising feature was the practical absence of accompanying cellular infiltration, only a few small round cells being visible in the patches. There was no vascularization or evidence of increase of connective tissue. The elastic tissue of the degenerated part of the media was granular and was demonstrated with difficulty. Some fibrin was present. The intima was not thickened, and nothing abnormal was noted in the adventitia save perhaps a slightly increased cellularity (small round cells).

Splenic Artery at the Opening into the Aneurysm.—Sections were made showing the ruptured splenic artery opening into the aneurysmal sac. The wall of the artery here showed more marked disease than that just described in the wall nearer the commencement of the artery, but the changes appeared to be of the same type.

The only coat affected around the whole circumference was the media, and here, as before, the more marked alterations were in its inner half. All round, the inner half showed extensive necrosis of the muscle fibres with karyorrhexis of the muscle nuclei which survived. There was more round-celled infiltration in this zone than in the corresponding zone in the previous sections, but it was not very marked. There was no definite vascularization or increase of connective tissue. The outer half of the media showed an extensive patchy loss of individual fibres and groups of fibres, granular fibrinous débris alone surviving in such patches.

The intima was not thickened all round, and in particular it was not altered at the point of connection with the aneurysm (on the side investigated). It showed, however, considerable cellular thickening in part of the circumference. In this part, the internal elastic lamina, which had been running close to the endothelium, suddenly passed outwards for a short distance, to disappear abruptly. The thickened intima here was composed of cellular connective tissue, the cells being mainly fibroblasts with some small round cells. A few capillaries were visible.

There was no fatty change in either intima or media save for a very fine dusting of the internal elastic lamina. There was extensive fibrosis of the surrounding pancreatic tissue, but no cellular infiltration of the adventitia.

The opening into the aneurysm was next studied. The vessel wall approaching this point showed an unthickened intima but a very extensive necrosis of the media, leaving only a narrow surviving band of relatively healthy muscle in its outer part. Opposite the aneurysmal opening this wisp of media stopped abruptly, a small hæmorrhage marking the site of its termination in some sections. Shortly afterwards the internal elastic lamina and endothelium stopped also, and finally the adventitia with its thin layer of elastic tissue disappeared. Beyond this no semblance of arterial wall persisted. The aneurysmal wall was formed of concentric layers of fibrosed pancreas, with an inner lining of adherent thrombus.

In certain other sections cutting through the opening of the artery into the aneurysm at a different point, the external and internal elastic laminæ both persisted, one on either side of the degenerated media, right up to where the aneurysm commenced ; the media then thinned out and stopped, and as it did so the laminæ approached one another, almost joining where the media stopped. Here the internal elastic lamina stopped abruptly, but the external elastic lamina continued as a few faint strands in the adventitial tissue for a little into the wall of the aneurysm (*Fig.* 160).

FIG. 160.—Opening into aneurysm. Wall of splenic artery to left, internal and external elastic laminæ converging from left to right, forming a triangle.

Discussion of Microscopic Appearances.—It seems clear that the medial degeneration and necrosis were the primary and chief factors leading to the formation of the aneurysm. The thickened intima found in parts is apparently secondary, representing an attempt to strengthen the weakened wall, and it may be noted that rupture occurred at a point where this thickening had not taken place. The process seems to have been of fairly recent origin, but the paucity of cellular infiltration is peculiar.

There is evidently no relation to atheroma or other generalized arterial disease. The appearances do not suggest syphilis. They do, however, suggest a subacute infection.

COMMENTS ON CASES.

This unfortunate experience induced us to look up the literature, and we were struck by our ignorance of the number of recorded cases. In the accompanying table (*see* p. 272) the chief features of 58 cases are summarized.

Etiology.—A study of these cases does not show any outstanding causative factor. Septic emboli, arteriosclerosis, and syphilis have been suggested, but in a number of instances all of these can be definitely excluded. A Wassermann reaction was not done in our case, but the family history did not suggest syphilis, nor did post-mortem examination reveal any stigmata of this disease. No history of a previous septic focus could be obtained, nor was one found post mortem. Direct or indirect trauma has been suggested as a cause in a few cases. There was no history of this in the present case, although the patient had lived a strenuous life as the wife of a small farmer.

Symptoms.—A history of discomfort in the left upper abdomen often closely simulating a gastric or duodenal ulcer was given in a number of the cases. In others a definite enlargement of the spleen or tumour mass in the left upper abdomen could be made out, while in still others the patient gave no history to suggest the presence of an abdominal lesion. When perforation occurs the picture is that of internal hæmorrhage, and in the female ectopic gestation has been the pre-operative diagnosis in a number of instances. When rupture of the aneurysm occurs in the late months of pregnancy the difficulties of diagnosis are very great indeed, and a concealed intra-uterine hæmorrhage is likely to be suspected.

Treatment.—Surgery offers the only hope of cure, and we believe that a wider appreciation of the possibility of the lesion will, as in other conditions, lead to earlier diagnosis and better results.

REFERENCES.

[1] THOMSON, *Johns Hopkins Hosp. Bull.*, 1928, March.
[2] SENGER, *Arch. of Pathol.*, 1928, Feb.

Table showing the references to 58 cases follows

TABLE SHOWING THE REFERENCES TO THE 58 CASES COLLECTED BY THE AUTHORS.

No.	AUTHOR	SEX AGE	SYMPTOMS	ANEURYSM	TREATMENT (OPERATION)	RESULTS	REFERENCES
1	Ahrens, M.	M. 26	Pressure and pain in stomach region, vomiting of blood; swelling of spleen; small pulsating tumours palpated	Size of a fist; ruptured into peritoneum	Patient died before treatment could be begun	Sudden death with signs of internal hæmorrhage	Inaug. Diss., Griefswald, 1892
2	Ayer, J. B.	F. 44	Hæmatemesis; severe abdominal pain	Rupture into stomach not stated	Morphine only mentioned	Sudden death	Boston Med. and Surg. Jour., 1883, cviii, 148.
3	Barlow	M. 61	No symptoms	Two aneurysms: 1 size of filbert nut, and 1 size of pea, about 1 in. apart	Not stated	Death	Trans. Pathol. Soc. Lond., 1899, i, 57
4	Baumgartner, E. A.	F. 48	Sudden abdominal pain; vomiting blood, and blood in stools; indigestion for some time	9 cm. in diameter, not ruptured	None	Death	Surg. Gynecol. and Obst., 1924, xxxix, 462
5	Beaussenat	M. 54	Ulcerations on legs; œdema of left leg; stomach dilated; constipation	Dilatation, 35 cm. long, sac 10 cm. in length, circumference of hen's egg	Local for ulcers; incisions for œdema	Death	Anat. Ges., Paris, 1892
6	Beussier	F. 60	—	One size of small walnut, others smaller	—	—	Jour. of Med.-Chir. Pharm., 1770, xxxii, 157
7	Berry, J. A.	F. 60	Those of carcinoma of stomach, which was present	Main artery and branches; 5 aneurysms, largest 1 in. in diameter	None	Death (from cancer of gall-bladder)	Lancet, 1927, i, 490
8	Binder	M. 47	Severe pain in region of spleen; later colicky pain; spleen enlarged	Size of walnut, ruptured into peritoncum	None	Death day before operation	Bruns' Beitr. z. klin. Chir., 1918, iii, 205
9	Corson, E. N.	—	The original article was not seen				Med. and Surg. Reporter, 1869, xx, 351
10	Crisp	M.	The original article was not seen			Death	Quoted by Zahn, 1847
11	Davidson, A.	—	—	One size of bean, 1 size of pea, and others smaller still	—	—	Liverpool Med.-Chir. Jour., 1884, iv, 210

No.	Name	Sex & Age	Symptoms	Description	Treatment	Result	Reference
12	Davis, B. F.	M. 67	Sudden appearance of tumour to left of umbilicus	One	Removed	Recovery	Jour. Amer. Med. Assoc., 1925, lxxxiv, 200; also Med. Press, 1925, N. s. cxix, 115
13	Fahrmann and Ugrumow	M. 50	Splenomegalia			Death	Arch. f. klin. Chir., 1925, cxxxvii, 193
14	Fitzwilliams, D. C. L.	F. 27	Sudden intense pain in pit of stomach; collapse, shock	8 cm. in circumference, 3 cm. from site of ligature	Splenectomy	Death	Brit. Med. Jour., 1924, ii, 803
15	Garland	M. 52	Dyspnœa on exertion; œdema	Three aneurysms, largest (ruptured, size of walnut) in hilus	Exploratory laparotomy	Death	Boston Med. and Surg. Jour.", 1921, clxxxiv, 385
16	Goodheart, J. F.	F. 49	Abdominal distension; headache, vomiting, and diarrhœa; thirst; loud blowing murmur on left side; hemorrhage per rectum	Ruptured into peritoneum. Sac about 3 cm. in diameter	Ruptured. Caused by abdominal paracentesis	Death	Trans. Pathol. Soc. Lond., 1889, xl, 67
17	Goullioud	F. 50	Tumour in left hypochondriac region for 4 or 5 years	Size of an orange. Contained large clot	Operation: removal of aneurysm	Recovery. Well after 12 years	Bull. et Mém Soc. nat. de Chir., 1928, liv, 402
18	Harnett	—	—	Size of hen's egg	None beyond tapping	Death	Ind. Med. Gaz., 1922, 457, lvii
19	Heppner	F. 58	Spleen greatly enlarged; pulsating tumour palpable and at times visible; occasional vomiting and diarrhœa; abdominal pain off and on for some years previously	Traumatic aneurysm	—	—	St. Petersb. med. Zeits. 1872, N. s. iii, 220
20	Hoegler	F. 61	Swelling in left hypochondrium with bruit; girdle pains	Three aneurysms, 7·5, 6·0, 5·0 cm., with smaller ones attached. Ruptured into peritoneum	—	Sudden death from internal hemorrhage	Quoted by Garland, Wien. Arch. f. int. Med., 1920, Aug., 543
21	Hunt	M. 70	Cerebral hemorrhage	One aneurysm (diagnosed during life as cancer of pancreas)	None	Death (cancer of pancreas also found)	Amer. Jour. Med. Sci., clxxvi, No. II, 195
22	Jourdan			No details given. Rupture into substance of pancreas		Death	Anat. Ges., Paris, 1881, iii, 76

No details given. The whole communication is as follows: "M. Jourdan showed a piece of aneurysm of the splenic artery burrowed into the head of the pancreas, and claimed that death was due to rupture into the peritoneum."

TABLE SHOWING THE REFERENCES TO THE 58 CASES COLLECTED BY THE AUTHORS—continued.

No.	Author	Sex Age	Symptoms	Aneurysm	Treatment (Operation)	Results	References
23	Leudet	F. 70	—	Two tumours: 1 size of pea; 1 size of filbert nut	—	—	Gaz. des Hôp., 1852, xxv, 583
24	Lindbom	M. 29	Severe abdominal pain. Swelling and pain in right shoulder	2·5 cm. long, 1·5 cm. broad	Drugs only	Died suddenly 8 days after admission	Zit. Thereb. Pathol. der Kreislauforgan Lucbarsch, Ostertag, 1915
25	Lundwall and Gödl	F. 29	Internal hæmorrhage in 9th month of pregnancy	Ruptured. 2 cm. in diameter 3 cm. from origin	Supravaginal hysterectomy	Death	Arch. f. Gynäkol., 1923, cxviii, 177. Abst.: Med. Jour. Amer. Assoc., 1923, lxxx, 1348
26	Marshall	F. 27	—	Traumatic (revolver)			Brit. Jour. Surg., 1921-2, ix, 570
27	Mayer	F. 29	Severe lower abdominal pain in 1st stage labour	Size of hazel-nut. In main artery. Ruptured just before. Pancreatic division. Pancreatic hæmatoma		Died 1½ hours after delivery	Zentralb. f. Gynäkol., 1928, lii, 754
28	Mayet	F. 59	Abdominal pain for 2 months before; vomiting after meals; loss of weight; hæmatemesis	Size of small nut. Ruptured into stomach	Alkaline waters	Death	Ann. Soc. méd. de Lyon, 1879, xxxi, 327
29	Monro	M. 23	Breathlessness on exertion; pain in chest and legs; swelling of feet.	Spherical, about size of tangerine orange. Filled with clot	Injections of antistreptococcus serum. No apparent benefit, but seemed to cause increase in urine	Death	Trans. Glasgow Pathol. and Clin. Soc., 1905-6, xi, 92; also Glasgow Med. Jour., 1907, lxvii, 309
30	Mulley	F. 23	Anemia; constipation; vertigo and faintness	Two aneurysms: 1 size of small apple, size of nut and 1 size of nut	Splenectomy	Complete healing	Beitr. z. klin. Chir., 1918, cxi, 205
31	Naber	F. 54	Feeling of fullness in upper abdomen for 3 months; tumour in left upper abdomen which slowly increased in size, noted for more than 1 year before; no great pain, no vomiting, no jaundice, urine normal	Not stated	Operation: Jan. 12, 1925. Removal of spleen with tumour	Complete recovery without complications. Discharged 14 days. In good health 17 months later	Deut. Zeits. f. Chir., 1926, cxcviii, 118

No.	Name	Sex/Age	Symptoms	Description	Operation	Result	Reference
32	Osler	M. 30	Tumour in left hypochondrium	Size of coconut	None	Death	Montreal Gen. Hosp. Rep., 1880, i, 266
33	Parker	M. (Age not given)	Rectal hæmorrhage; slight dyspepsia; pain in back	Size of small orange		Death 1½ hours after admission to hospital	Edin. Med. and Surg. Jour., 1844, lxii, 132; also Dublin Quart. Jour. Med. Sci., 1844, xxvi, 124
34	Renmels	F. 38	Sudden attack of severe abdominal pain at end of pregnancy	2 cm. long	It was intended to operate, but patient died during preparation for laparotomy	Death	Nederl. Tijds. v. Verlosk. en Gynaec., 1928, xxxvii, 41; also trans.: Zentralb. f. Gynäkol., 1928, lii, 167
35	(a) Reynolds		The original article was not seen				
	(b) van Rooy		The same case, original not seen				
36	Rolleston	F. 37	Not stated. Post-mortem description	Branch. Size of a cherry			S. Afric. Med. Record, 1906, iv, 267; Nederl. Maandschr. v. Geneesk., 1927, xiv, 507 (in Dutch)
37	Saenger	F. 40	Internal hæmorrhage	Size of hazel-nut 6 cm. from hilum	Operation	Death	Trans. Pathol. Soc. Lond., 1898–9, 1, 55
38	Suntesson		The original article was not seen			Death	Zentralb. f. Gynäkol., 1926, i, 1324
39	Schroeder	F. 32	Hæmolytic jaundice and splenomegalia	Two aneurysms. 1 9 cm. from hilum; 1 at hilum, size of hazel-nut	Operation for splenectomy abandoned	Death	Fürth Svens. Läk-Sällsk. Stockholm, 1848–9, 1849
40	Schultze	F. 62	None	Ruptured aneurysm at middle of the pancreas. Found post mortem		Death	Arch. f. Klin. Chir., 1924, cxxxii, 175
41	Selten	F. 31	Hemiplegia	Saccular: accidentally found post mortem	None	Death	Zeigler, Beitrage, 1905, xxxviii, 374
42	Smith, H. B. W.	F. 35	Abdominal pain	Ruptured into peritoneum. Branch at hilum		Death. No definite aneurysm found at site of rupture	Virchow's Arch., 1893, cxxxiv, 189; Brit. Med. Jour., 1911, 83

TABLE SHOWING THE REFERENCES TO THE 58 CASES COLLECTED BY THE AUTHORS—continued.

No.	Author	Sex Age	Symptoms	Aneurysm	Treatment (Operation)	Result	References
43	Smith, W. R.	F. 38	Diagnosed as ruptured ectopic gestation	'Large tumour' 3 in. long, Retro-pancreas. Peritoneal rupture	Exploratory laparotomy	Death	Jour. Amer. Med. Assoc., 1923, lxxx, 1692
44	Tarozzi	F. 45	Post-mortem report. Aneurysm not suspected durng life	Size of filbert nut	—	Died of cancer of stomach	Ital. Lit. ref. Central. f. Psych., 1904, xv, 700
45	Taylor	M. 14	Pains in joints; paroxysms of precordial pain	Large	None	Death 2 days after admission	Eng. Lit., 1915; Glasgow Med. Jour., 1911, lxxv, 249.
46	Teacher	F. 43	Pain in left hypochondriac region, constipation, vomiting	Four aneurysms about ½ in. diameter	None	Death 2 days after admission	Trans. Pathol. Soc. Lond., 1903, liv, 302
47	Trevor, R. S.	M. 53	Entered hospital for operation hydrocele: operation performed. Great tendency to haemorrhages. Diarrhœa and haemorrhage from bowel two days after	Aneurysm of walnut size up of 2 pouches. Another aneurysm ½ in. away, size of hen's egg. Splenic vein dilated	—	Death 13 days after operation	Trans. Pathol. Soc. Lond., 1885, xxxvi, 151
48	Turner, F. C.	M. 37	Not stated. Sudden death	Size of an orange; rupture into peritoneum	Cyst opened and packed	Death	Arch. gén. de Chir., 1912, viii, 749; also Lyon méd., 1912, cxviii, 830
49	Villard and Murard	M. 33	Epigastric swelling and pain	—	Anti-rheumatic drug treatment	Sudden death	Deut. med. Woch., 1908, xxxiv, 177
50	Walz	M. 27	Shivering; joint pains; spleen enlarged; anaemia; painful	Ten aneurysms from ¼ in. to ½ in. in size, walls ossified	Opiates for pain only	Death one week after examination	Boston Med. and Surg. Jour., 1856, liv, 297
51	Ware, J.	F. 72	Diarrhœa; severe abdominal pain; vomiting; retention of urine; abdomen much swollen	1.7 cm. diameter. Branch... Ruptured vein. into...	Not stated	Death	Ges. Abhandlungen, ... Arch. f. pathol. Anat., ...
52	Weigert	F. 40	Not given. Post mor. ten report only				

No.	Name	Sex/Age	Symptoms	Findings/Size	Treatment	Death during labour	Reference
53	Wesenberg	F. 32	Collapse and death after birth of a still-born child	5 cm. long, 1 to 2 cm. thick at hilum. Ruptured into peritoneum	—		Zentralb. f. Gynäkol., 1912, xxxvi, 463
54	West, S.	M. 56	Hæmorrhage per anum; vomiting	Branch. Ruptured into stomach. Size not given	Not stated	Death	Lancet, 1885, 518
55	Winckler	F. 25	Splenomegalia	Not stated. At hilum	Splenectomy	Death	Zentralb. f. Chir., 1905, xxxii, 257
56	Yolland	F. 27	Collapsed, no diagnosis possible	'Small'	None	Death	Brit. Med. Jour., 1925, i, 600
57	Zahn	M. 44	Hæmatemesis and melæna	Size of nut. Perforated into stomach and transverse colon	—	Death	Virchow's Arch., 1891, cxxiv, 238
58	Zannini		The original article was not seen				Gaz. med. ital. prov. veneti Padova, 1880, xxiii, 296

SECONDARY HYDROCEPHALUS AS A FACTOR IN THE DIAGNOSIS AND LOCALIZATION OF INTRACRANIAL TUMOURS; WITH ITS INVESTIGATION AND TREATMENT.*

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SUMMARY OF CONTENTS.

I. INTRODUCTION.

THOUGH the symptoms of hydrocephalus secondary to an intracranial tumour are usually regarded as being essentially those of the underlying condition, it frequently happens that no localizing signs whatever are present. In such cases the intracranial tumour itself may remain latent throughout the greater part or whole of the clinical course, and the symptoms be entirely those of acute or subacute hydrocephalus—that is to say, those which are usually regarded as the 'general symptoms' of brain tumour, namely, headache, vomiting, vertigo, and papillœdema. In some cases, however, the vertigo may suggest the presence of a tumour in or adjacent to the posterior fossa of the skull, and result in a presumptive localization of the lesion which may be adduced as evidence in favour of a decompression operation below the tentorium rather than above it; or mental symptoms may appear early in the course of the condition and suggest the presence of a tumour in the frontal lobe rather than one in the base of the brain obstructing the outflow of cerebrospinal fluid from the lateral ventricles. Thus 'false localizing signs'

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may appear and lead to an erroneous localization and to fruitless attempts at exploration and removal. False localizing signs have been recognized as occurring frequently as a result of vascular changes and œdema of the brain in association with intracranial tumours, but hitherto they have not been recognized as a potential source of error in those cases in which a tumour of the brain has produced internal hydrocephalus. Even when they have been regarded as sources of error, it has not always been recognized that the key to a complete diagnosis depended upon the diagnosis of hydrocephalus on the basis of the so-called general symptoms of tumour of the brain ; or that often the general symptoms present are the result of secondary hydrocephalus, and the localizing signs present are due to the hydrocephalus and not to the tumour itself. Because of the possibility of error in diagnosis in such cases, it has been thought advisable, using seven typical cases as a text, to consider the influence of secondary hydrocephalus upon the diagnosis and localization of intracranial tumours ; to consider the means whereby the presence of hydrocephalus as a complication and the exact localization of the tumour may be determined ; and to discuss the influence of such a complication upon the choice of treatment.

II. THE CIRCULATION OF THE CEREBROSPINAL FLUID.

Though it was suggested by Faivre[1] in 1854 that the choroid plexuses were the source of the cerebrospinal fluid, it was not until 1919, when Dandy[2] published the results of his experiments, that it was proved that they were its only source. The way in which it is produced is still in doubt, for by different observers it has been thought to be produced by filtration and by secretion. That the constituents of the blood-plasma are present in it in about the same proportions as in the blood seems to indicate that the process is one of filtration, but the holding back of some substances artificially introduced into the blood-stream suggests that the cells of the choroid plexus have some power of selection over the substances which pass into the cerebrospinal fluid.

Though some of the cerebrospinal fluid may pass into the perivascular spaces, it is probable that most of it is absorbed into the veins. The observations of Weed[3] showed that this absorption of cerebrospinal fluid probably takes place in the subarachnoid space by a process of diffusion, but there is some evidence that absorption of cerebrospinal fluid takes place into the spinal veins as well.

The circulation of the cerebrospinal fluid is a more or less independent one of its own within and without the brain and spinal cord, consisting primarily of a steady tide from its source in the choroid plexuses to the area of absorption in the subarachnoid space and the spinal canal, together with certain superadded waves imparted to it by the vascular pulsations operating within the rigid cranium. The fluid constantly accumulates within the lateral ventricles and circulates in only one direction. From the lateral ventricle it passes through the foramina of Monro into the third ventricle, through the aqueduct of Sylvius into the fourth ventricle, and thence, by way of the foramen of Magendie and the foramina of Luschka, into the subarachnoid spaces about the brain and the spinal cord.

III. THE ETIOLOGY OF HYDROCEPHALUS IN INTRACRANIAL TUMOURS.

Four different mechanisms have been suggested to explain the development of hydrocephalus in the course of intracranial tumours :—

1. Direct mechanical obstruction of the circulation of the cerebrospinal fluid depends upon the accidental localization of the tumour in such a position that it directly impinges upon the channels through which the fluid normally circulates. This effect is produced by tumours blocking one or both foramina of Monro, involving the third ventricle, obstructing the aqueduct of Sylvius, involving the fourth ventricle, or obstructing the foramina of Luschka or that of Magendie. The inevitable result of tumours so placed is the accumulation of cerebrospinal fluid above the level of the obstruction. In these cases hydrocephalus and 'general symptoms' usually appear early, and localizing signs are often absent or appear late as 'false localizing signs'. Such true localizing signs as are present are soon obscured by general symptoms and false localizing signs, so that an error in localization is particularly apt to occur. Since, however, in these cases any treatment adopted must be essentially general, at least in the first place, in that it is determined by the general symptoms of the patient, the initiation of effective treatment must depend upon the prompt recognition of the presence of hydrocephalus. Such a prompt diagnosis is particularly necessary in the case of a tumour or other lesion in the sites already mentioned. It is possible that in such cases the primary mechanical obstruction is only partial and that the vicious circle set up by the gradual development of hydrocephalus disturbs the adjacent brain tissue and makes the obstruction complete, thus hastening the development of general symptoms and at once placing the patient in a dangerous condition. Such is the urgency of the problem presented when secondary hydrocephalus is the result of mechanical obstruction to the circulation of the cerebrospinal fluid. It is even more urgent in those cases in which hydrocephalus is produced indirectly by a tumour situated in other parts of the brain, as, under those conditions, the chances of employing effective local treatment are greater. The mechanism by which the tumour produces secondary hydrocephalus in such cases is at present undecided.

2. By some writers the indirect production of hydrocephalus is believed to be due to pressure upon the great vein of Galen, either directly or indirectly, and the consequent increased production of cerebrospinal fluid by the choroid plexuses in the lateral ventricles. Basing his argument partly upon anatomical and partly upon clinical evidence, Stopford[4] has recently described this mechanism as the only important one in the indirect production of hydrocephalus in cases of intracranial tumour. Sargent[5] has, however, described an anatomical feature of the opening of the great vein of Galen into a lacuna at the posterior end of the free border of the falx cerebri which would make this mechanism unlikely in the absence of direct mechanical obstruction of the vein by pressure against adjacent parts. Stopford, however, overcomes this difficulty by pointing out that hydrocephalus is more common in cases of tumour of the posterior part of the cerebrum and of the posterior fossa, and concludes that this localization supports his suggestion that direct pressure

is produced upon the great vein of Galen either from above or below as a result of the unyielding character of the tentorium cerebelli. Dandy[2] believes that obstruction of the great vein of Galen is a rare cause of secondary hydrocephalus. It is possible that it is a cause in some cases and a contributing factor in many.

3. Actual distortion of the brain-stem by lateral displacement and torsion, and secondary obstruction to the circulation of the cerebrospinal fluid at its most vulnerable point in the aqueduct of Sylvius by pressure of the hindbrain against the unyielding edge of the tentorium cerebelli, has been suggested as a more probable explanation. Russell Brain[6] believes that this is the mechanism operating in the majority of cases of intracranial tumour complicated by hydrocephalus, and cites in support of it the frequency with which distortion of the brain-stem is found at autopsy in cases of secondary hydrocephalus.

4. In addition, it has been suggested that the obstruction to the circulation of the cerebrospinal fluid occurs in the neighbourhood of the foramen magnum. An increase in the intracranial volume, especially above the tentorium, results in the expulsion of cerebrospinal fluid, pressure is exerted upon the contents of the posterior fossa of the skull, the structures in the neighbourhood of the foramen magnum are displaced, and the outlets of the cerebrospinal fluid are obstructed. Thus a vicious circle is set up and internal hydrocephalus rapidly develops.

It is possible that the first three of the factors mentioned may all play some part in individual cases ; but, whatever mechanism is chiefly responsible, it is important to recognize that, apart from those cases in which direct mechanical obstruction has occurred, the hydrocephalus is the direct result of increased pressure within the cranium and that, once it has begun to develop, a vicious circle is established which soon results in the development of a condition which endangers the vision if not the life of the patient.

It is equally important to recognize that in those cases in which secondary hydrocephalus has developed indirectly, the order in which the symptoms and signs appear is of paramount importance—true localizing signs first if the part affected is not a silent area, general symptoms of increased intracranial pressure, followed by false localizing signs as a result of the increased intracranial pressure. It is true that the different phases may merge into one another. but it is none the less essential that the sequence of events should be remembered if errors in localization are to be avoided.

IV. PERSONAL CASES.

Case 1.—Glioma and diffuse gliosis of the pons, with secondary hydrocephalus and symptoms suggestive of a cerebellar lesion.

H. A., male, age 30 years, was admitted on Sept. 11, 1928, complaining of headache, vomiting, loss of vision, dizziness, and hæmatemesis of six weeks' duration.

HISTORY.—The patient was perfectly well until six weeks before admission. The illness began with pain in the back of the neck. There had been severe headache on the top of the head, varying somewhat from time to time. Vomiting had been present daily since the onset and was worse when the headache was severe. Blood appeared in the vomitus on one occasion. The vision was less acute, and

the patient had been disinclined to read on account of the headache. He staggered as he walked. The previous history was negative, but two of the patient's family had had tuberculosis, and one had died of it.

ON EXAMINATION.—The mental condition was normal. There was some concentric narrowing of the visual fields, more obvious on the left side. There was some blurring of the optic discs, but no obvious swelling could be seen. Nystagmus : slight, irregular jerks were present, more on looking to the left than to the right ; there was a long, slow swing on looking to the left. Hearing was diminished in both ears, and bone conduction was more prolonged than air conduction. There was no evidence of active disease in either the right or the left ear. Some words were slurred in speaking. The left corneal reflex was sluggish. There was slight weakness of the lower part of the right side of the face for voluntary movements. The other cranial nerves were normal.

In the upper limbs motor power was poor, tone was decreased equally on the two sides, and the deep reflexes were present and equal. In the lower limbs motor power was poor, tone was decreased more in the left leg than in the right, the knee- and ankle-jerks were more active on the right side than on the left, and the plantar reflexes were doubtful. The abdominal reflexes on the right side were less active than those on the left. The patient walked on a broad base, swayed from side to side, and tended to go towards the left. There was tremor of the left hand and arm on extension. With the finger-nose test there was slight tremor on movement towards an object, more obvious in the left hand than in the right. Rebound was not so good in the left arm as in the right. With the heel-knee test there was no obvious abnormality. The pulse-rate was 70 ; the blood-pressure was 135 systolic, and 90 diastolic. The other systems were normal.

There was tenderness below the external occipital protuberance on percussion. On X-ray examination the left mastoid cells were not so clear as the right.

The cerebrospinal fluid was normal. The Wassermann reaction in the fluid was positive with 5 minimum hæmolytic dilutions. In the blood the Wassermann reaction was negative.

SUBSEQUENT PROGRESS.—Sept. 15, 1928.—The patient was shivering and complaining of the cold frequently, a symptom which had been present since the onset of the illness.

Sept. 18.—There was a feeling of chilliness and dampness in the distribution of the first and second divisions of the left trigeminal nerve. On objective examination there was analgesia in the distribution of the ophthalmic division of the left trigeminal nerve, and impairment of pain sensation in that of the maxillary division.

Oct. 3.—The optic discs were slightly more blurred. Vomiting was not so frequent, but headache was more frequent. There was complete analgesia and loss of tactile sensation in the first and second divisions of the left trigeminal nerve.

Oct. 9.—There was definite nystagmus on looking to the left. The patient walked staggering from side to side with the head bent forward on the chest. There was pain in the back and some difficulty in passing urine.

Oct. 11.—Both optic discs were swollen to 4 dioptres. The retinal veins were distended and there were hæmorrhages in the retina.

Oct. 13.—An operation was performed to decompress the posterior fossa and the supratentorial region immediately above it. Above the tentorium the dura mater was very tense on both sides, more so on the left side. Below the tentorium the dura was not unusually tense. Before the operation, while anæsthesia was being induced, there was some difficulty with breathing which was overcome as soon as the intratracheal tube was inserted. About ten minutes after the operation respiration ceased, but recovered with artificial respiration. Six hours after the operation the patient had not recovered consciousness, and the respiration was more rapid and stertorous. Death occurred suddenly.

POST-MORTEM FINDINGS.—Nothing abnormal was found in the bones of the skull or the dura. The convolutions of the brain were very greatly flattened, pale,

and anæmic. The pons and the medulla appeared to be much flattened, distinctly broadened, and their surface markings were obliterated as if from pressure from within the brain. On section, the lateral ventricles were much distended and the aqueduct of Sylvius was obstructed at the level of the pons. The third ventricle and infundibulum were also distended.

Microscopically, complete vertical sections through the pons and medulla showed, at about the junction of the two, a large, more or less diffuse glioma, varying much in structure in different parts—in some more cellular, in others more fibrillary. The general type was that of a spongioblastoma multiforme, with spindle-shaped, irregular and some gliomatous giant cells. There was a diffuse ' gliosis ' or ' gliomatosis ' around the more definite area of tumour on the left side of the pons. Some of the little vessels in the tumour and neighbourhood showed aggregations of small lymphocyte-like cells around them.

Case 2.—Glioma of the cerebellum and secondary hydrocephalus in a child; obesity; symptoms simulating those of a degenerative condition of the cerebellar and pyramidal tracts. (*Figs.* 161, 162.)

H. G., female, age 4 years, was admitted on Aug. 29, 1928, with a history of difficulty in walking for eighteen months.

HISTORY.—Up to eighteen months before admission the development of the child had been normal. Then it was noticed that she had some difficulty in walking, which became progressively worse until she was unable to stand. Shortly afterwards a squint appeared and gradually became more obvious. Her previous health had been good, and two other children in the family were healthy.

ON EXAMINATION.—The child was intelligent and well-developed. The skull was abnormally large, but no gross abnormality was found radiologically. The gait was very ataxic, and walking without support was impossible. There was a right external strabismus, but no evidence of diplopia could be elicited. The ocular movements were inco-ordinated, but there was no definite nystagmus. The ocular fundi showed definite optic atrophy. The deep reflexes were exaggerated, and the plantar reflexes were extensor on both sides. There was no obvious interference with cutaneous sensibility. Excepting for the presence of 4 cells per c.mm., the cerebrospinal fluid was normal.

At a subsequent examination the following additional signs were noted. The pupils were equal and moderate in size, reacting sluggishly to light and accommodation. The right corneal reflex was sluggish. The left side of the face was weak for voluntary movements. The upper limbs were normal. Motor power and muscle tone were apparently good in the legs ; the knee- and ankle-jerks were exaggerated, those on the right side being more active than those on the left. Co-ordination was good in the arms, but much impaired in the legs. There was some urgency of micturition. The skull was rather large, and its circumference (21¾ in.) approximated to that of the chest.

SUBSEQUENT PROGRESS.—Nov. 4, 1928.—The mental condition was good throughout. There was slight variation from time to time in the signs of a pyramidal lesion, the plantar reflexes being sometimes flexor and sometimes extensor. For a period of one week the patient was very drowsy and took little interest in her surroundings.

Dec. 3.—The right lateral ventricle was punctured through an opening in the skull above and behind the right ear. Eighty c.c. of cerebrospinal fluid were withdrawn in small amounts at a time, and replaced at each stage by air. At the end of the operation the patient vomited, the breathing became stertorous, and coma suddenly supervened. On the withdrawal of a small amount of cerebrospinal fluid the breathing became normal and consciousness was regained. The patient slept a little after the operation and for four hours was apparently normal. She then became cyanosed and died suddenly.

X-ray examination after the injection of air showed that the right ventricle

was very large. No air had entered the left ventricle. The appearance of the skull
suggested hydrocephalus.

POST-MORTEM FINDINGS.—The brain was distinctly large for a child of this
age, showed great general flattening, and gave the impression of a thick bag full

FIG. 161.—*Case 2.* Glioma of the cerebellum, secondary hydrocephalus, and obesity in
a child : showing tumour and dilatation of the infundibulum.

of fluid. The infundibulum was ballooned out into a thin-walled sac, and on
section the lateral ventricles were much distended and full of fluid, with thinning
of the overlying brain tissue. A very irregular sheet of tumour was found over

the cerebellum and the neighbouring parts of the pons and medulla, and around the seventh and eighth cranial nerves on the right side. The tumour formed a thick collar around the medulla, lay in the foramen magnum, and probably caused compression. The naked-eye appearance of the tumour was suggestive
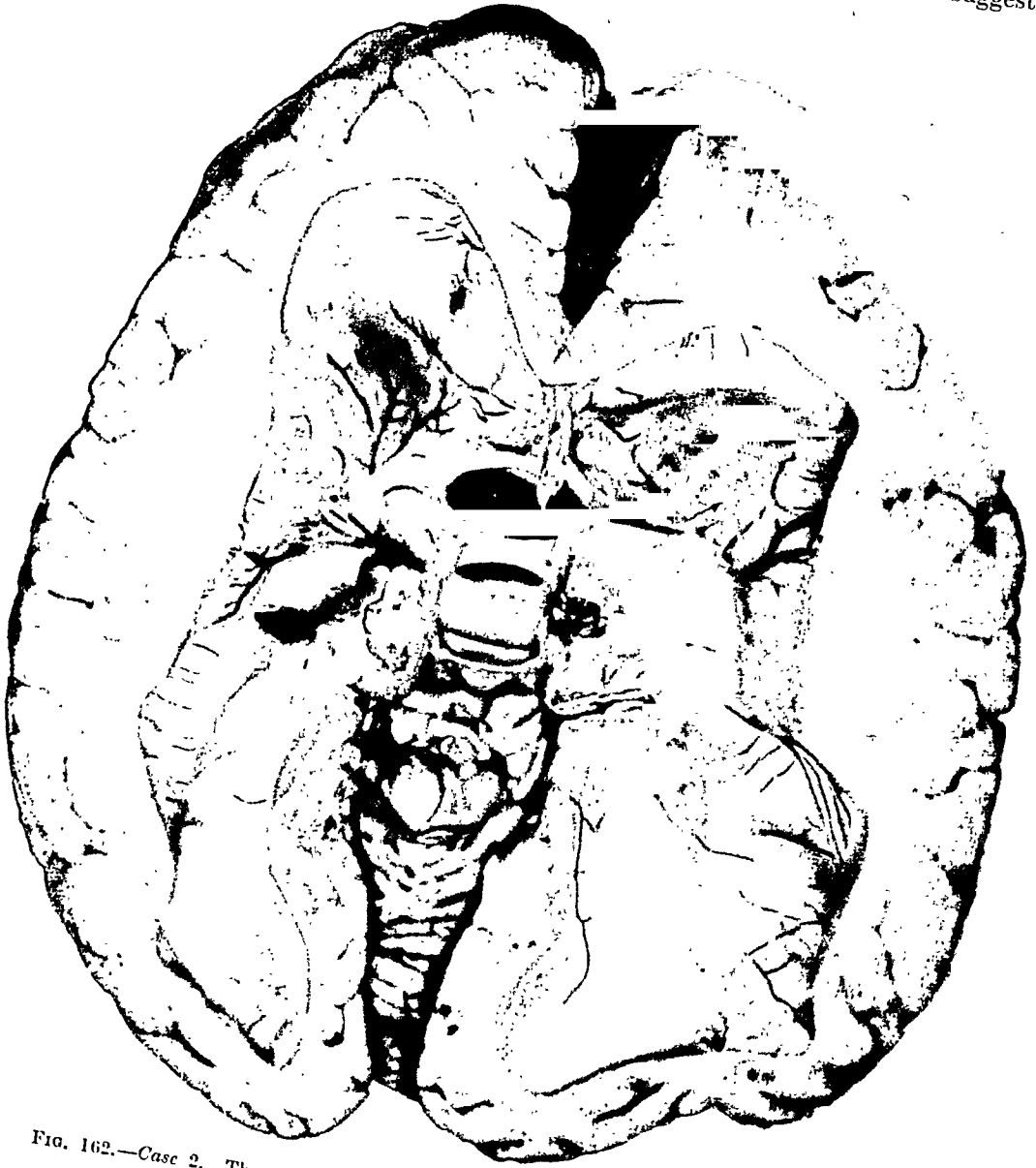
FIG. 162.—*Case 2.* The same as *Fig. 161* showing dilatation of the third and lateral ventricles, and collar of tumour above the cerebellum.

of endothelioma. Sections, however, showed a highly cellular tumour, actively malignant—gliomatous with numerous small glial cells and a rich glial network— a fibrillary astrocytoma.

Case 3.—Glioma of the third ventricle and infundibulum, with secondary hydrocephalus and symptoms suggesting a tumour of the frontal lobe. (Figs. 163, 164.)

M. H., female, age 45 years, was admitted on June 14, 1928, complaining of 'a nervous breakdown', irritability, poor memory, headaches, vomiting, and loss of energy of eight months' duration.

HISTORY.—The patient began to suffer from lack of energy about eight months before admission. For many years she had had headaches on top of the head and in the occipital region. During the previous six months they had been severe and
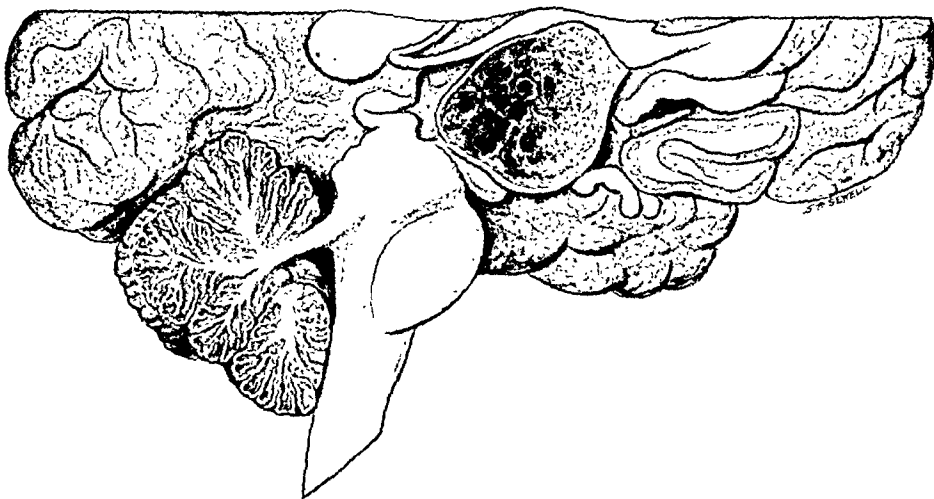
FIG. 163.—Case 3. Glioma in the region of the third ventricle and infundibulum with secondary hydrocephalus : sagittal section showing position of the tumour.
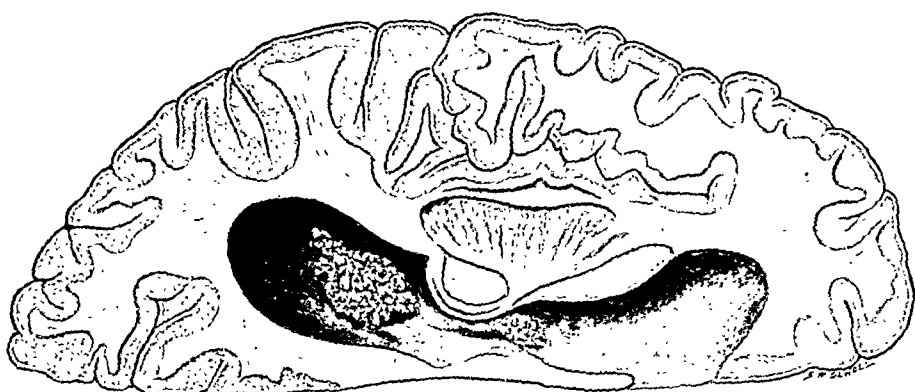
FIG. 164.—Case 3. The same as Fig. 163, showing dilatation of lateral ventricle.

associated with attacks of vomiting and nausea. During the same time the memory had been getting steadily worse. Although irritable at times, for the most part the patient had been happy and contented, and did not appear to realize the seriousness of her mental deterioration. The previous history was negative. With regard to the family history, the patient's husband was alive and well and she had three children living, one with heart disease.

ON EXAMINATION.—The mental condition was best described as facile; the patient showed a tendency to joke in everything she said. The memory was very poor, especially for recent events; words spoken a few minutes before could not be recalled. Attention could not be maintained. The right pupil was slightly larger than the left, and both reacted to light and accommodation. The right optic disc was swollen to 2 dioptres, and the left to 4 dioptres with hæmorrhages into the retina. Vision was fairly good. The visual fields could not be measured satisfactorily on account of inattention, but there appeared to be extreme concentric contraction of the fields on both sides. The other cranial nerves were normal.

Sensation was normal. In the upper limbs muscle tone was slightly greater on the right side, and the tendon reflexes were present and equal on the two sides. In the lower limbs muscle tone was slightly greater on the right side, the knee- and ankle-jerks were present and equal, and the plantar reflexes were both flexor. The abdominal reflexes were present and equal. There was tremor of the right hand and arm on extension. The finger-nose test was carried out clumsily, worse on the right side than on the left. There was incontinence of fæces. The blood-pressure was 120 systolic, and 70 diastolic. The other systems were normal.

SUBSEQUENT PROGRESS.—A decompression operation was performed in the left fronto-parietal region and the dura opened. No local abnormality was found.

June 27, 1928.—The patient was still comatose twenty-four hours after the operation.

June 28.—The patient was conscious, but unable to speak or swallow. The right arm and leg were spastic, and the right side of the face was paralysed. The temperature was raised, and the pulse- and respiration-rates were increased. Death occurred the following day.

POST-MORTEM FINDINGS.—The convolutions of the brain showed considerable general flattening due to a moderate degree of hydrocephalic dilatation of the ventricles. In the region of the infundibulum there was a slightly projecting, firm, rounded swelling suggestive of a subjacent tumour. On vertical section this was found to be due to a globular glioma-like tumour about the size of a walnut, centrally placed, and occupying the position of the third ventricle and infundibulum. The tumour was slightly whiter and more spongy than the surrounding brain tissue; and its centre showed some patchy, reddish-brown mottling suggestive of necrosis, with dilated vessels and some small areas of hæmorrhage.

Microscopically. sections showed the tumour to be a glioma of the spongioblastoma multiforme type with considerable variations in the cells, some showing as branching astrocytes, others as spindle-shaped to entirely irregular cells. There were areas of necrosis, and in some parts dilated and congested vessels from some of which hæmorrhage had occurred.

Case 4.—Endothelioma (meningioma) of the fronto-parietal lobe, with secondary hydrocephalus, glycosuria, and sudden death. (*Figs.* 165, 166, 167.)

L. P., female, age 27 years. was admitted on Sept. 16, 1927, in a state of coma.

HISTORY.—Headache had been present for one year, and gradually increasing drowsiness for three weeks. Mental symptoms had been present for a few days before admission.

ON EXAMINATION.—The temperature was 97·8° and the pulse-rate 68. The patient was in resistant coma, incontinent of urine, and just reacted to painful stimuli. All the reflexes were increased. There was slight head retraction, and the right side was stiff. The blood-pressure was 124 systolic, and 75 diastolic. The cerebrospinal fluid was not under pressure. was clear, contained 10 lymphocytes per c.mm. and 0·1 per cent of protein. There was a loose cough, but no adventitious sounds were discovered in the chest. The urine was normal.

SUBSEQUENT PROGRESS.—Sept. 17, 1927.—The patient could be roused, and spoke about her pain. Papillœdema was present on both sides, on the right side to 3 dioptres and on the left side to 2 dioptres.

Sept. 18.—The coma was increasing, and the limbs showed flaccidity and rigidity at different times.

Sept. 19.—Coma was complete, and the temperature, pulse-rate, and respiration-rate were increasing. The limbs were completely flaccid. The pupils were moderate in size, the left larger than the right, and both were fixed. The abdominal reflexes were absent and plantar reflexes flexor. Severe sensory stimulation caused slight
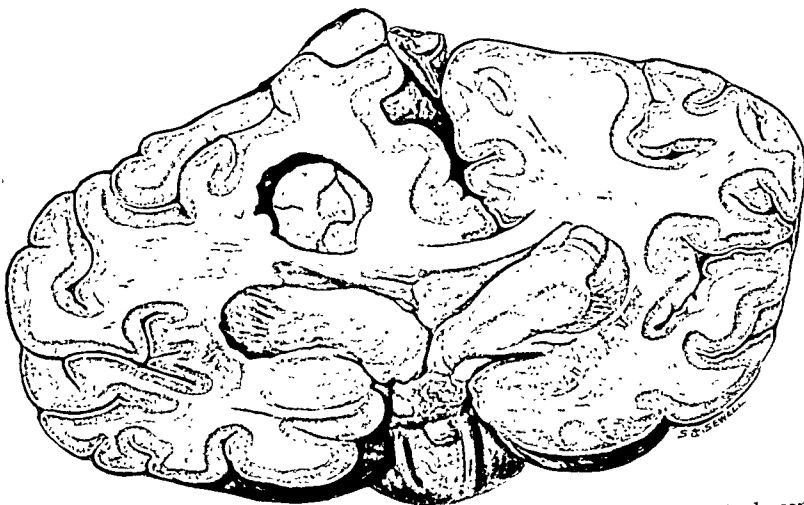
FIG. 165.—*Case* 4. Meningioma of the fronto-parietal lobe with secondary hydrocephalus : showing displacement of structures in the middle line to the opposite side.
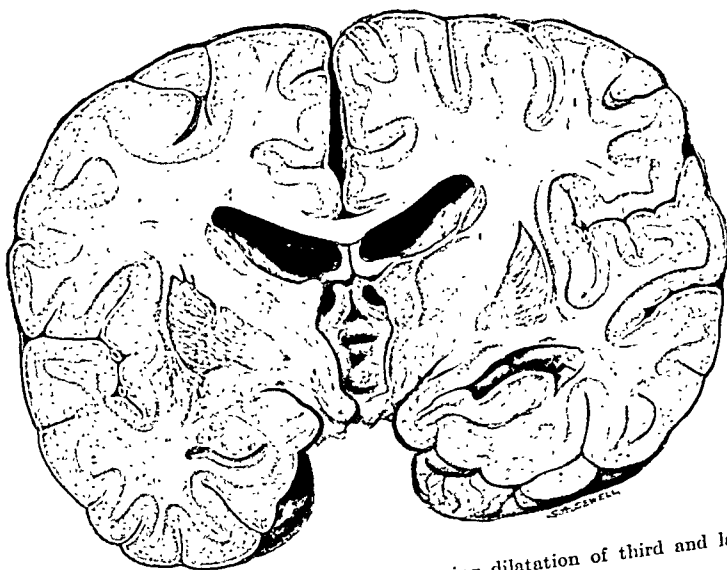
FIG. 166.—*Case* 4. The same as *Fig.* 165, showing dilatation of third and lateral ventricles, and of foramina of Monro.

movement. The papilloedema was increasing. The urine was acid, contained no albumin, but there was a moderate amount of sugar and acetone.

The operation of decompression was about to be performed, but the patient's respiration failed during the shaving of the head ; death ensued.

POST-MORTEM FINDINGS.—An endothelioma (meningioma) was found in the left frontal region and pressing on the Rolandic area. There was also marked hydrocephalus with pressure on the medulla.
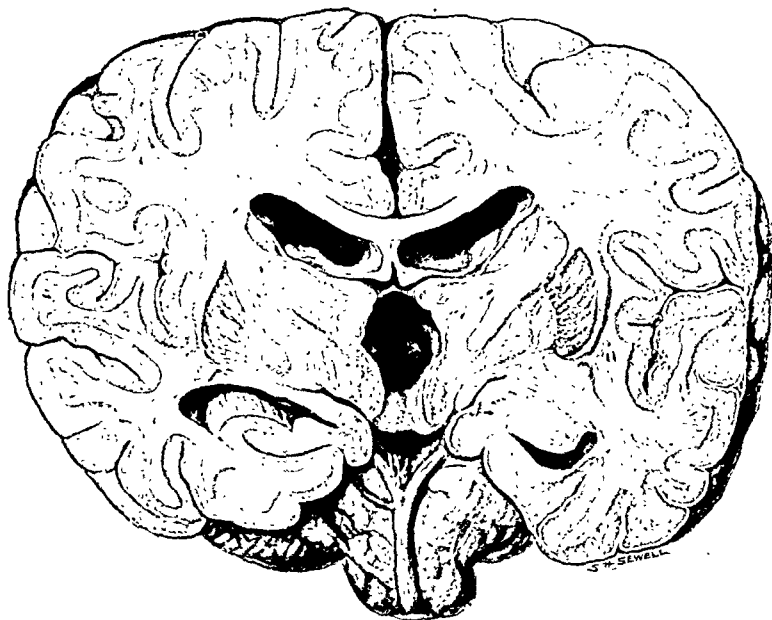
FIG. 167.—*Case* 4. The same as *Fig.* 165, showing dilatation of the third ventricle and the aqueduct of Sylvius.

Case 5.—Glioma of the cerebellum, secondary hydrocephalus, and signs suggestive of a supratentorial tumour.

R. B., male, age 25 years, was admitted on Jan. 17, 1927, with a history of headache and vomiting for two months.

HISTORY.—Two months before admission the patient complained of bitemporal headaches and pain in the back of the neck. Speech became defective and was progressively worse before admission. Vision was progressively impaired and the gait became unsteady.

SUBSEQUENT PROGRESS.—Optic neuritis was evident one month after admission. Vomiting occurred occasionally every day, especially in the morning or at midday. A right subtemporal decompression was performed one month after admission, and a left subtemporal decompression one month later. Nothing abnormal was noted at the time of either operation.

The physical signs one week after the second operation were as follows. The right pupil was smaller than the left, and both reacted sluggishly. A divergent strabismus was present and the movements of all muscles supplied by the third nerve were weak. There was marked papillœdema of both optic discs, more obvious on the right side. There was a flaccid paralysis of the right side of the face and slight weakness of the left side. The patient refused to speak, but understood much of what was said. Hearing was diminished. The tongue protruded towards the right side. The condition of the sensory system was difficult to determine, but no gross loss was detected. A right-sided hemiplegia appeared after the second operation. In the upper limbs the tendon reflexes were more active on the right side than on the left. In the lower limbs the knee- and ankle-jerks were present and equal, ankle clonus was present on the right side, and the right plantar reflex resulted in dorsiflexion. The abdominal reflexes were absent on the right side. Incontinence of urine and fæces appeared after the second operation. The other systems were normal.
Death occurred fourteen weeks after admission.

POST-MORTEM FINDINGS.—The whole brain was extremely soft and, especially over the upper part of the cerebral hernia, breaking down and necrotic. After fixation the brain was cut in a series of horizontal sections and a large cerebellar tumour was found. The tumour was more or less centrally placed in the cerebellum, its lower part rather more to the right and its upper part slightly towards the left. It was soft, slightly pinkish-grey to ash-coloured, and fairly well-defined in its circumference, which was mostly in contact with and more or less embedded in distorted cortex. In the substance of the tumour there were a few small necrotic pseudo-cysts.

Microscopically, the tumour was highly cellular, the cells being 'undifferentiated' with small rounded to slightly oval nuclei, rich in chromatin and staining darkly, with a small to moderate amount of surrounding protoplasm, the outlines of which are very indefinite. The cells showed a distinct tendency to be arranged in irregularly rounded islets or alveoli, with thin-walled capillaries and scanty delicate connective tissue between them forming a scanty reticulum around these islets. According to Bailey and Cushing's classification, the tumour appeared to be a 'medulloblastoma'.

Case 6.—Cerebellar arachnoid cyst, with secondary hydrocephalus and symptoms suggesting a lesion of the pyramidal tracts. (*Fig.* 168.)

W. S., male, age 36 years, was admitted on Oct. 25, 1928, complaining of pain and stiffness in the back of neck.

HISTORY.—Three months prior to admission the patient began to have pain at the back of the eyes at the end of the day, after work. This pain had gradually
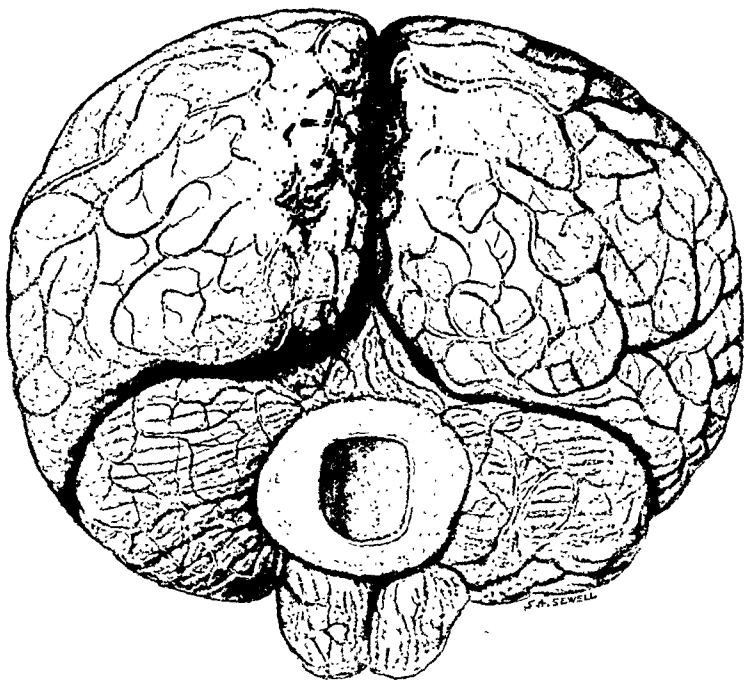
FIG. 168.—*Case* 6. Cerebellar arachnoid cyst with secondary hydrocephalus: showing cyst and flattening of the cerebral convolutions.

spread backwards, and at the time of admission it centred at the back of the neck and the muscles there seemed stiff. His previous health had been good.

ON EXAMINATION.—The pupils reacted to light and accommodation. Vision and the visual fields were normal. The optic discs on both sides were indistinct.

and there was a small hæmorrhage in the right retina. There were no nystagmus, sensory changes, or tremor of the hands, and the arm-jerks were normal. The knee-jerks were exaggerated, the ankle-jerks were present, there was a tendency to ankle clonus, and the plantar reflexes were extensor. The Wassermann reaction was positive in the blood and cerebrospinal fluid.

SUBSEQUENT PROGRESS.—Oct. 27, 1928.—Lumbar puncture was performed and the fluid was under pressure. The patient stood it very well and there was no severe reaction.

Oct. 30.—The patient was allowed up in the afternoon as he said that the headaches, which were not relieved by lumbar puncture, were easier when he was up. He appeared as usual at night and slept well until 5.30 a.m. He then said he was not feeling well and looked tired. Five minutes later he was found propped up in bed, cyanosed, covered with cold perspiration, and quite unconscious. The breathing became feebler, the pulse was slow and weak, and the patient died within twenty minutes.

POST-MORTEM FINDINGS.—The brain showed flattening of the convolutions and a convex bulge on the left side. Some of the surface vessels were obliterated. The cerebrospinal fluid was clear, and a large amount of fluid was present in the cerebellar fossa. The vermis of the cerebellum and the pons were compressed and flattened. In the middle line at the base of the cerebellum a space two inches in diameter was occupied by a thin-walled cyst. The arachnoid membrane in the region of the right auditory nerve was much thickened. The ventricles of the brain were distended with clear fluid. The cyst was diagnosed as a cerebellar arachnoid cyst.

Case 7.—Glioma of the upper pons, midbrain, and interpeduncular space, secondary hydrocephalus and symptoms suggesting congenital hydrocephalus. (*Figs. 169. 170.*)

J. P., male, age 6 years, was admitted on April 12, 1926.

HISTORY.—At the age of 5 months the patient was diagnosed as suffering from primary optic atrophy of both eyes. He complained of slight pain in the left leg about four months before admission. One month later he had a sudden attack of headache, vertigo, and vomiting. He was unable to walk after this attack, and trembling of the hands and knees appeared. His condition became steadily worse, his character changed, he became perverse and difficult to manage.

ON EXAMINATION.—The pupils were equal and dilated, and did not react to light. The right eye was completely blind ; with the left eye he could count fingers. There was weakness of both external recti, and the eyes could not be elevated above the mid-horizontal line. Both optic discs showed secondary optic atrophy. There was difficulty in opening the mouth. There was weakness of voluntary movements of the face on the left side. The pulse was rapid. There was bilateral spastic paraplegia. The patient was unable to feed himself, and had incontinence of urine and fæces. He died on the seventh day after bilateral subtemporal decompression.

POST-MORTEM FINDINGS.—The head was of distinctly large size as compared with the rest of the body. The skull was very thin, and both anterior and posterior fontanelles were still membranous. The convolutions of the brain showed definite flattening and pallor. A soft, tumour-like mass was found in the interpeduncular space, extending from the upper margin of the pons to well in front of the optic chiasma. The mass involved the chiasma, the tuber cinereum, and the infundibulum, and extended on each side to the tips of the temporosphenoidal lobes. The pituitary fossa was pressed upon, and was wider and shallower than normal. The pituitary body was pressed against the bottom of the fossa, and was saucer-shaped and widened. The posterior halves of the intracranial parts of the optic nerves were involved in the tumour ; the left being narrowed and degenerated, the right being soft, bulky, and œdematous. The sixth nerves appeared to be compressed against the bone by the tumour.

On horizontal section of the brain a marked degree of chronic hydrocephalus

was apparent, involving both the lateral and third ventricles. Embedded in the floor of the third ventricle there was a soft, rounded pinkish-brown tumour, projecting rather more to the right side than to the left. The tumour appeared to be cystic in nature, but, on cutting into it, it was found to be soft peripherally, and necrotic and hæmorrhagic in the centre.

Microscopically, the tumour was composed of small cells with dense, spherical nuclei, surrounded by a rather indefinite, feebly-staining cytoplasm. Between them
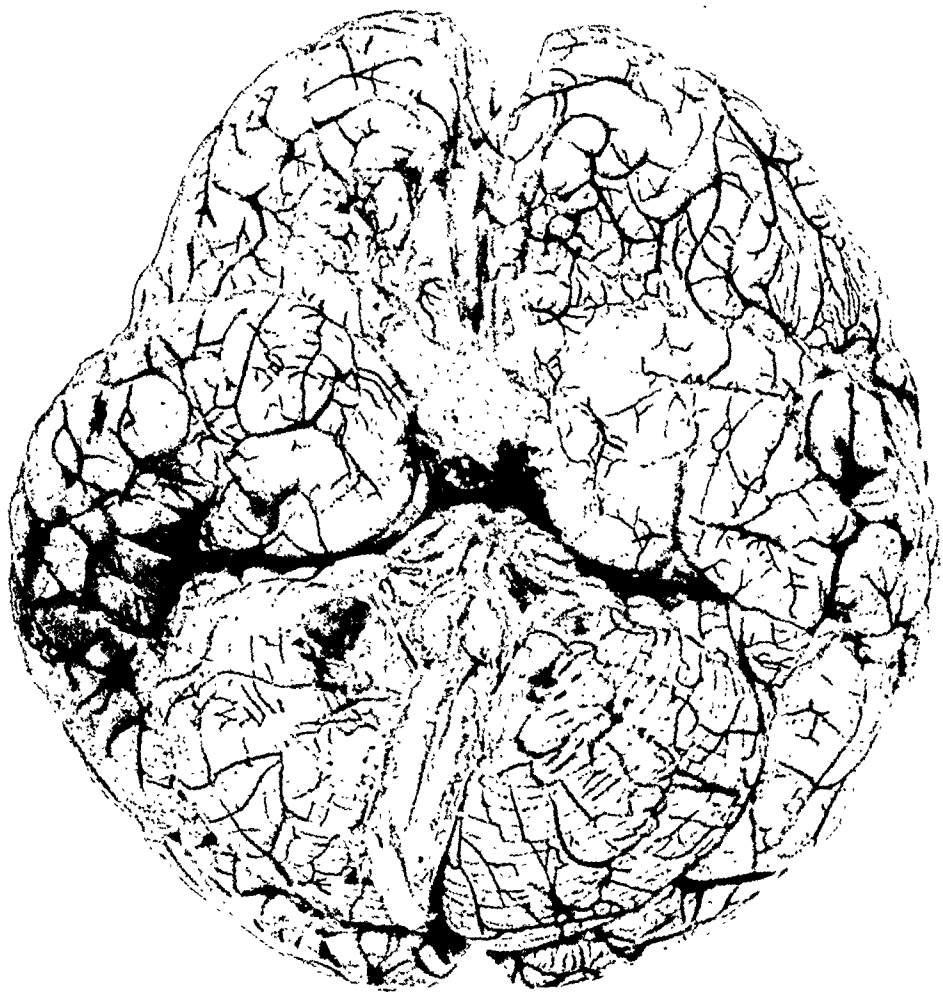
Fig. 169.—*Case* 7.   Glioma of the upper part of the midbrain and the interpeduncular space in a child : view of brain and tumour from below.

was an indefinite material which did not stain for neurofibrillæ, neuroglia. or for connective tissue. Some of the small blood-vessels showed proliferation of their endothelial cells, sufficient in some cases to fill their lumen and form little solid masses. Both optic nerves showed thickening of their fibrous tissue and framework, with in the left advanced, and in the *right* complete, atrophy and disappearance of the nerve-fibres.

V. CLINICAL COMMENTARY.

The cases detailed above illustrate most of the points of interest in the diagnosis of cases in which secondary hydrocephalus is a complication and in the localization of the focal lesions present.

Case 1 was that of a man of 30 who for six weeks had suffered from head-

Fig. 170.—Case 7. The same as Fig. 169: the tumour and lateral ventricles viewed from above.

ache, vomiting, loss of vision, and vertigo. Physical examination revealed a series of signs—nystagmus, hypotonia, a tendency to fall towards the left—which seemed to point to a lesion of the left side of the cerebellum or adjacent to it. The symptoms continued and became more acute, the patient reeled as he walked, the head was carried forward on the chest, and the optic discs,

which at first were only blurred, in three weeks were found to have swollen to 4 dioptres. In addition there appeared analgesia in the ophthalmic and maxillary divisions of the left trigeminal nerve, and doubtful signs of a pyramidal lesion on the right side. A tumour of the posterior fossa of the skull was diagnosed and a subtentorial decompression advised. At the operation and at the subsequent autopsy it was found that the whole of the increase in intracranial tension was above the tentorium and that there was no increase in tension whatever below the tentorium. In reviewing the clinical features of the case the general symptoms were accepted as general symptoms of an intracranial neoplasm, and as such localizing signs as were present pointed to involvement of the cerebellum, a diagnosis was made of a tumour of or adjacent to the cerebellum, and treatment was advised accordingly. Subsequent review of the whole case showed that probably the more correct interpretation of the clinical features was as follows. The general symptoms were the result of increased intracranial tension above the tentorium as the result of hydrocephalus. The cerebellar signs were the result of secondary pressure upon the contents of the posterior fossa, and not to direct involvement of or pressure upon the cerebellum by the tumour itself. It is true that the diffuse gliosis of the pons was adjacent to the cerebellum, but it was not of such a character as to produce the cerebellar signs by direct pressure. The cerebellar signs were, in fact, false localizing signs secondary to the internal hydrocephalus and not true localizing signs. The case raises the question of the value of the localizing signs present, and of the correct interpretation of the so-called general symptoms of intracranial tumour.

Case 2 was that of a girl, age 4 years, who had been unable to walk for eighteen months and had had ataxia of the lower limbs only during that time. Because of the poor mentality of the parents certain important points in the history of the child were wanting. On examination the child was found to have an unusually large head, optic atrophy on both sides, varying signs of involvement of the pyramidal tracts, and ataxia of the lower limbs. Throughout the illness the mentality of the child was perfectly good, and excepting for a period of one week when she was unusually drowsy there were no symptoms directly suggesting the presence of an intracranial tumour. The conditions to be considered in diagnosis appeared to be a degenerative condition involving the pyramidal and cerebellar tracts, a chronic inflammatory condition involving these tracts and the optic radiations, and the effects of a previously undetected hydrocephalus. The congenital form of hydrocephalus was excluded because the development of the child had been apparently normal in every respect up to the age of 3 years, and the acquired form because there was no history of an inflammatory condition within the skull. With a view to clearing up the problem ventriculography was carried out. Internal hydrocephalus was proved to be present, but the cause of it was still unexplained. The alarming symptoms of the child immediately after the injection of air into the lateral ventricles and her sudden death some hours later raised the question of the advisability of performing ventriculography in such cases, of the best method to be employed, and of the cause of the accidents which sometimes attend this procedure. Subsequently autopsy showed that internal hydrocephalus was present, and was the result of

obstruction to the outflow of cerebrospinal fluid by a tumour of the inferior part of the cerebellum. In addition to the points in connection with ventriculography mentioned above, this case raised the question of differential diagnosis in the presence of hydrocephalus, and of the importance of a detailed history in the presence of this complication.

Case 3 was that of a patient, age 45, who had suffered from a nervous breakdown, loss of energy, mental irritability, an increasingly poor memory, headache, and vomiting for eight months. On examination the only physical signs present were inequality of the pupils, doubtful constriction of the visual fields, a slight increase in muscle tone on the right side of the body, and bilateral papillœdema more obvious on the left side. The general symptoms seemed to point to the presence of an intracranial tumour, and the abnormal mental state suggested that it was in the frontal lobe ; while the difference in the muscle tone on the two sides with tremor and clumsiness of the right arm seemed to be in favour of a localization in the left frontal lobe rather than in the right. A decompression operation was consequently done over the left fronto-parietal region, and the patient died two days later of a subdural hæmorrhage. The autopsy revealed the presence of dilatation of the lateral ventricles more pronounced on the left side than on the right caused by a tumour of the upper part of the midbrain and the septum pellucidum. This case again raised the question of the significance of the general symptoms of intracranial tumour, and of the localizing value of the symptoms and signs usually thought to be associated with lesions of the frontal lobes. The indefinite localizing signs present in this case were again false localizing signs produced by secondary hydrocephalus.

Case 4 was an example of secondary hydrocephalus due to the vicious circle set up by a tumour so situated that it could not directly block the circulation of the cerebrospinal fluid. A patient who had been increasingly drowsy for three weeks and had shown mental symptoms for a few days was admitted in a state of coma. Following admission a number of interesting points were noted in connection with the clinical features : (1) The limbs of the right side were stiff, and there was some retraction of the head, but as the coma increased the limbs showed alternating flaccidity and rigidity, and finally became completely flaccid. (2) In the early stages the reflexes were all increased, but as the coma deepened they became less active and control of the organic reflexes was lost. (3) When the pulse-rate was 68 and the temperature subnormal the urine was perfectly normal; but, as signs of bulbar paralysis appeared, the temperature rose and glucose and acetone appeared in the urine. A further interesting point was the fact that a tumour, which must have been developing in a silent area of the brain for a long period, suddenly gave signs of increased intracranial tension, probably from indirect pressure on the medulla, and produced a fatal result within three weeks of the first indication of the presence of an intracranial condition. In this case prompt recognition of the presence of secondary hydrocephalus and adequate treatment of that condition could have led to the complete removal of the tumour itself. In addition to the points mentioned in connection with the previous cases, this case shows that secondary hydrocephalus due to a tumour not directly obstructing the circulation of cerebrospinal fluid

can arise *de novo*; it also raises the question of the significance of glycosuria as a symptom in cases passing into coma with only papillœdema to indicate that increased intracranial tension is present.

Case 5 was that of a patient who had bitemporal headache and pain in the back of the neck for two months. In addition the speech was progressively defective, and walking was becoming more and more unsteady. The signs of increased intracranial tension were present—namely, vomiting and papillœdema. The clinical features of the case at the time, not described in detail in this paper, appeared to point to a tumour of the frontal lobe as the cause of the symptoms ; but, in view of the indefinite localization of the lesion and the urgency of the general symptoms, measures were adopted to relieve the increased intracranial tension. At the autopsy there was found a central tumour of the cerebellum obstructing the circulation of the cerebrospinal fluid and producing internal hydrocephalus. In this case the signs of a cerebellar lesion were apparently so indefinite, those of increased intracranial pressure so definite, and those of a lesion of the frontal lobe so suggestive, that a diagnosis was made of a frontal rather than of a cerebellar tumour. Closer attention to the sequence of events might have shown that the difficulty with speech and the impairment of gait were present from the onset of the clinical history, whereas the general symptoms were late in appearing and comparatively slow in developing—a sequence which would have suggested that more attention should be paid to the symptoms of a lesion of the posterior fossa, even though they were apparently indefinite. The physical signs which appeared after the two operations cannot be included in this discussion, as it is probable that they were, in some measure at least, dependent upon pressure effects in the neighbourhood of the operation areas. This case suggests, therefore, that in the presence of secondary hydrocephalus it is essential to make a careful study of the order in which the various symptoms and signs have developed, even in cases in which they are indefinite, in order to distinguish true and false localizing signs.

Case 6 was an example of a patient who had a quiescent arachnoid cyst of the cerebellum which finally produced secondary hydrocephalus. The chief points of interest in the case are the absence of symptoms of the focal lesion, and the slight indications of involvement of the pyramidal tracts apparently resulting from the secondary hydrocephalus alone.

Case 7 was that of a patient who had been affected since early infancy, and in consequence the clinical findings closely resembled those of the congenital form of hydrocephalus. At the age of 5 months he had been diagnosed as suffering from primary optic atrophy. From that age until three months before death the clinical picture was that of a slight degree of congenital hydrocephalus. At that time he had a sudden attack of headache, vomiting, and vertigo, after which he was unable to walk, and trembling of the hands and knees appeared. At that stage there appeared certain physical signs which indicated that there was a lesion involving the midbrain, and it was also recognized that the changes in the optic discs were characteristic of secondary and not of primary optic atrophy. At the autopsy there were found changes characteristic of secondary hydrocephalus involving the third and the lateral ventricles ; also a tumour mass in the floor of the third

ventricle and obstructing the circulation of the cerebrospinal fluid below that level. The remarkable feature of the case was that, apart from the optic atrophy, there were no general symptoms of increased intracranial pressure for over five years, while definite localizing signs of the tumour appeared only after the increase in intracranial pressure had been present for that time. The case illustrates the similarity of the clinical features of secondary hydrocephalus arising as the result of a tumour in infancy to those of congenital hydrocephalus; also the adaptation of the skull of the child to the increasing pressure to such a degree that, apart from the optic atrophy and the impairment of vision, no general symptoms of increased intracranial pressure were present except during the short attack three months before death.

VI. SECONDARY HYDROCEPHALUS AS A FACTOR IN DIAGNOSIS.

The symptomatology of secondary hydrocephalus *per se* would appear to be much more extensive than is usually thought. In general that of acquired hydrocephalus differs considerably from that of the congenital form of the disease. When, however, the condition arises very early in infancy or even in early childhood, as in *Cases* 2 and 7, it may closely imitate the congenital form. Enlargement of the head, a cracked-pot sound on percussion, and separation of the sutures may be present in secondary hydrocephalus which has begun in early childhood.

The statement frequently quoted in text-books that the symptoms of hydrocephalus caused by brain tumour are essentially those of the underlying condition is apt to be misunderstood. It would probably be more correct to say that cases of cerebral tumour, both those in which focal signs have been present and those in which they have been absent, are liable to develop symptoms of secondary hydrocephalus. In the former group the appearance of focal symptoms followed by general symptoms at once leads to the correct diagnosis of an intracranial tumour; but in the latter group such a diagnosis would be purely presumptive. Conditions other than an intracranial tumour may lead to the development of an intracranial state which produces all the general symptoms present in cases of tumour. These general symptoms—headache, vomiting, vertigo, and increasing papilloedema—are essentially the symptoms of increased intracranial tension, and those which may occur with secondary hydrocephalus from any cause. Each of them alone may be present as a result of increased intracranial tension, or as a symptom of other conditions to be referred to later.

When localizing symptoms *appear after the development of general symptoms*, they may be either *true* or *false* localizing signs, and a careful review of the clinical features of the case is necessary in order to estimate their true value in diagnosis. Such false localizing signs may be: general constriction of the visual fields, paralysis of lateral deviation of the eyeballs on one or both sides, mental symptoms suggesting a lesion of the frontal lobe, unilateral or bilateral symptoms suggesting slight interference with the pyramidal and sometimes the cerebellar tracts, symptoms and signs suggesting a lesion of the cerebellum, signs of pituitary dysfunction, unilateral or bilateral deafness, and tinnitus.

It is evident, therefore, that in the presence of the general symptoms of intracranial tumour arising *de novo* it is unsafe to diagnose an intracranial tumour on them alone without further investigation to determine the cause of the increase in intracranial tension; and, further, that it is unsafe to rely upon localizing symptoms which have developed subsequently in making such a diagnosis and in localizing the lesion unless they are beyond all doubt and are supported by other signs which place the lesion in the same position.

The differential diagnosis in a case showing the general symptoms which may be present with secondary hydrocephalus is a matter of some importance. Souttar[7] has stressed the importance of the differential diagnosis in cases associated with increased intracranial tension from such general conditions as renal disease, severe anæmia, and lead poisoning. In cases in which the tumour is placed in the frontal lobe and there is pressure either direct or indirect on the medulla, the differential diagnosis from diabetes mellitus may cause difficulty. In *Case* 4 the only method of differentiation between diabetes mellitus and increased intracranial tension during the later stages was the presence of papillœdema, and the same difficulty arose in connection with one of the cases reported by Bingel.[8] The cerebral form of disseminated sclerosis, in which retrobulbar neuritis is placed so far forward as to involve the optic disc, may cause difficulty in some cases; while the rare cases of papillœdema with transverse myelitis may cause confusion when the condition of the optic disc appears before that of the cord. Such general conditions are, however, readily excluded by a careful general examination of the patient.

Once it has been established that the general symptoms are the result of increased intracranial tension, it is necessary to decide whether they are due to massive tumour growth, œdema of the brain, general circulatory changes, or internal hydrocephalus. In those cases in which one or more localizing signs have been followed by the general symptoms of increased intracranial tension, a satisfactory working diagnosis is usually made at this stage, and, according to Russell Brain,[6] the presence of hydrocephalus may be suggested by early and frequent vomiting and the rapid development of papillœdema. When, however, there have been no localizing symptoms before the onset of general symptoms and the presence of secondary hydrocephalus is suspected, the problem is to prove that it is present, to determine the site of the lesion, to give a reasonable opinion as to its nature, and to advise the correct treatment. Ventriculography is, as a rule, the most useful method available for establishing the diagnosis and localizing the lesion; but it is not always advisable to use it. Penfield[9] recommends that this method should be avoided when there is much increased intracranial tension, but goes on to say that if the diagnosis of increased intracranial tension is certain, "air injection is of the greatest assistance and should prevent many negative explorations: it should therefore be used without hesitation in such cases" with the object of demonstrating the presence or absence of a tumour, and of determining the size and position of the ventricles. Grant[10] states that in 392 cases examined by ventriculography, that method of examination was of value in localization in 311 (79·3 per cent); while in 93 cases (23·0 per cent of the total) the lesion was localized on ventriculography alone. Of the latter. 44 cases (11·2 per cent of the total, or 40·0 per cent of the 93 cases) were

amenable to surgical treatment—figures which dispose of the idea that it is only the deep-seated inoperable tumours which are identified by ventriculography alone.

Having decided that a blockage to the outflow of cerebrospinal fluid is present, it is necessary in view of the treatment to be adopted to decide what is the cause of the blockage. Dandy and Blackfan[11, 12] showed that hydrocephalus might be : (1) Obstructive, due to congenital malformation, an inflammatory process, or to a tumour in any part of the ventricular system, but usually at the aqueduct of Sylvius, the foramen of Magendie, or the foramina of Luschka ; or (2) Communicating, due to a barrier of adhesions at the base of the brain preventing the cerebrospinal fluid circulating through the cerebral subarachnoid space. Such adhesions are usually the result of meningitis occurring either before or after birth, and frequently so mild as to be overlooked. This was pointed out by Hilton and of later years by Fraser and Dandy,[13, 14] who stressed the fact that not only post-inflammatory adhesions in the cisterna magna, but also congenital maldevelopment of the subarachnoid space, tumour of the brain-stem, and abscess in the same region acted similarly. Young[15] reported a case in which the clinical history was very suggestive of brain tumour, but in which hydrocephalus was present and disappeared after eight years. In some of the cases of hydrocephalus developing as a result of the above conditions a detailed history may be of considerable value in determining the presence of post-meningitic adhesions or abscess, while a history of focal symptoms before the development of general symptoms may serve to establish a tumour as the cause of the blockage. But when all the clinical methods have been employed there will still remain a proportion of cases in which there is no clue to the nature of the condition, and it is in these that the use of ventriculography is particularly necessary if the patient is to have his chance.

The risk of withholding this method of examination is much greater than that of using it, and, in view of Grant's[10] figures, it seems perfectly justifiable to use it even in face of the apparent risks in order to diagnose and localize the proportion of lesions which are amenable to surgical treatment in such cases.

VII. SECONDARY HYDROCEPHALUS AS A FACTOR IN LOCALIZATION.

It has been pointed out above that all localizing symptoms which develop after the appearance of general symptoms of increased intracranial pressure must be regarded with suspicion ; and that they may be used for localizing the lesion only if they are clear and unmistakable evidences of a focal lesion.

Of these false localizing signs, those suggesting involvement of the cerebellum are probably the most common. Nystagmus, hypotonia, intention tremor, and other symptoms of a cerebellar lesion may be present. They were present in Case 1, but were never sufficiently definite to make a diagnosis of a cerebellar lesion on them alone. They have been referred to by other writers. In Young's[15] patient fine nystagmus on lateral deviation, hypotonia of the limbs, and intention tremor were present, and disappeared on the

recovery of the patient. Two more definite cases were reported by Bramwell, [16, 17] both of internal hydrocephalus in which cerebellar signs were pronounced—in one of them the result of posterior basilar meningitis and in the other the result of obstruction at the foramen of Magendie by adhesions. Spiller[18] recorded a case of hydrocephalus with cerebellar signs in which at autopsy only hydrocephalus due to obstruction and closure of the aqueduct of Sylvius was found. Oppenheim[19] recognized the close association of the clinical signs of brain tumour and internal hydrocephalus in two cases, in one of which cerebellar signs were present, and at autopsy only internal hydrocephalus was found. Rhein[20] reported a case with cerebellar signs in which there were cystic dilatations of the lateral recesses of the fourth ventricle in the neighbourhood of the cerebellopontine angle. These examples of cerebellar signs appearing in cases of hydrocephalus are sufficient to show that, under such conditions, cerebellar signs which are not absolutely definite and develop with or after the appearance of general symptoms of increased intracranial tension are false localizing signs, and, as such, are of no value whatever in determining the site of the lesion.

In *Case* 3 the symptoms were strongly suggestive of a lesion of the frontal lobe of the brain. For eight months the patient had had a 'nervous breakdown', and had suffered from headache, vomiting, irritability, loss of memory, and loss of energy. On examination it was found that her mental condition was facile, there was a certain degree of euphoria, the recent memory was defective, and the facetiousness and jocularity or 'Witzelsucht' mentioned by Oppenheim and other writers was very definite. There was no focal lesion whatever present in the frontal lobes, and it was evident that the internal hydrocephalus was entirely responsible for the symptoms mentioned. Russell Brain[6] mentions mental deterioration and irritability as common symptoms of cerebral tumour complicated by hydrocephalus, and stated that in one case dysphasia was present. Though never very definite as localizing signs of a frontal lobe lesion, it is obvious that such symptoms must always, in the presence of unmistakable evidence of increased intracranial tension, be looked upon with suspicion and regarded as false localizing signs.

In this case the erroneous localization in the frontal lobe was supported in some measure by the fact that there were slight indications of involvement of one pyramidal tract, probably, as it proved, because one foramen of Monro was obstructed before the other and the corresponding lateral ventricle more distended than that on the other side. Though in this case the signs were quite indefinite, it is apparent that minor signs of a pyramidal lesion, upon which in obscure cases much reliance is apt to be placed in the attempt to determine the side of the lesion, may also be false localizing signs as a result of secondary hydrocephalus. Similar signs were also present in *Case* 6. The indications of a lesion of one pyramidal tract were more definite in one of the cases reported by Oppenheim.[19] In this case there were bilateral optic atrophy, contracture of the sternomastoid and trapezius, weakness of the left leg, an extensor plantar reflex on the right side, and exaggerated deep reflexes. Russell Brain[6] also includes involvement of the pyramidal tracts as a result of hydrocephalus and characterized by weakness, spasticity, and bilateral extensor responses as a feature of hydrocephalus complicating brain tumour.

Signs of pituitary dysfunction may appear in the course of long-standing hydrocephalus and lead to the suspicion that the pituitary gland is primarily at fault. In *Case* 1 concentric contraction of the visual fields was present even before the signs of papilloedema were evident. In *Case* 2 the child had become unusually obese since the onset of the illness, during which internal hydrocephalus had evidently been present for from eighteen months to two years. In *Case* 3 there was again, as far as could be determined, definite concentric contraction of the visual fields—a finding which led to the suspicion at one stage that a suprasellar tumour might be the cause of the symptoms. In this case, however, the position of the tumour suggested that the contraction of the visual fields might not be due entirely to hydrocephalus, but *Case* 1 suggested that the contraction might be due to the hydrocephalus alone. More definite accounts of the occurrence of the signs of pituitary lesions in the course of hydrocephalus have been recorded in the literature. Jacobaeus[21] reported the case of a female, age 20 years, who suffered from dystrophia adiposogenitalis, and had choked discs and other signs of increased intra-cranial tension. By means of ventriculography the diagnosis of hydrocephalus was established, and at the autopsy it was found that the only pathological condition present was internal hydrocephalus due to absolute obstruction of a chronic inflammatory nature in the aqueduct of Sylvius. In Young's[15] patient, at the age of 16, after hydrocephalus had been present for eight years, the weight was 162 lb., the sugar tolerance was slightly increased with a raised threshold, and the skiagram showed the presence of hydrocephalus and an enlarged sella turcica. Cushing[22] reported several cases in which hydro-cephalus was associated with posterior-lobe insufficiency, and one in which there were acromegalic features. Marienesco and Goldstein[23] reported two cases of hydrocephalus with adiposity of the female type and genital hypo-plasia, one with a cyst of the cerebellum and the other of unknown etiology. Kurt Goldstein[24] reported three cases of hydrocephalus in which changes in the sella turcica were noted together with obesity and under-developed genitalia; and similar cases have been reported by Stumpf,[25] Pollock,[26] Strauch,[27] and Schultz.[28] In Russell Brain's[6] 60 cases of cerebral tumour there were two which showed adiposity and infantilism of the Frölich type. It is evident, therefore, that in recent cases of hydrocephalus with headache, vomiting, vertigo, and papilloedema, the presence of bilateral constriction of the visual fields may lead to the erroneous conclusion that a suprasellar tumour is responsible for the condition; and that, in cases of longer standing, the signs usually associated with pituitary dysfunction, including changes in the sella turcica itself, may appear probably as a result of constant pressure on the hypothalamic region and the infundibulum.

Bilateral deafness was present in *Case* 2 and has been associated with tinnitus in several cases observed by us. In *Case* 2, in particular, it was found necessary to exclude the possibility of an intracranial complication of middle-ear disease before considering other explanations of the patient's condition.

Thus cerebellar signs, evidence of lesions in the frontal lobe, changes in the visual fields, minor signs of involvement of the pyramidal tracts, and signs of pituitary dysfunction and chiefly hypofunction, minor or fully-developed according to the duration of the condition, may appear in the

course of secondary hydrocephalus due to obstruction to the outflow of cerebro-spinal fluid from any cause. Certain other signs occurring in the course of hydrocephalus and liable to be interpreted as localizing signs will be mentioned in the account of the clinical investigation of the condition. These signs are false localizing signs and, in cases in which the diagnosis of internal hydro-cephalus is established or even suspected on the symptoms present, must be carefully considered and their time relations to the general symptoms deter-mined before they can be used in the localization of the primary lesion.

VIII. THE INVESTIGATION OF SECONDARY HYDROCEPHALUS AND THE RESULTS OBTAINED.

The investigation of a case in which secondary hydrocephalus may be present is carried out by : (1) *Clinical methods—that is, a careful and detailed examination of the central nervous system ;* (2) *Puncture methods, including lumbar puncture, cisternal puncture, and ventricular puncture ;* (3) *X-ray examination ;* (4) *Ventriculography ; and* (5) *Observations made at the time of the operation.* These methods of examination are considered in turn, the clinical features which may be present in association with secondary hydro-cephalus are described both as regards their value as symptoms of the condition and in relation to the possibility of confusion with those of focal lesions, and the indications both for and against the more technical methods of examination are detailed.

1. CLINICAL METHODS.

The symptoms of secondary hydrocephalus may appear secondary to those of a local lesion of the brain or of the cranial cavity, or may arise *de novo* in a patient who has been previously in good health. The chief symptoms of secondary hydrocephalus are essentially those which are usually regarded as the general symptoms of a cerebral tumour. They are primarily the symptoms of increased intracranial tension and may be due to conditions other than hydrocephalus. There are, however, certain symptoms and signs which appear earlier or more frequently in the presence of hydrocephalus, and serve in some measure to differentiate that condition from the other causes of increased intracranial tension.

The general symptoms of secondary hydrocephalus are well known. Headache is probably the most frequent symptom, but its severity depends upon the rapidity with which the obstruction to the circulation of the cerebrospinal fluid develops, and upon the non-yielding character or otherwise of the skull itself. After it has once appeared it seldom disappears com-pletely, though it is subject to considerable fluctuations. It is usually described by the patient as a dull ache, or more often as a dull sense of pressure within the head, associated with a slight sense of physical ill-being or nausea which prevents him fixing his attention upon any occupation or recreation for any length of time. It is varied at times by acute exacerbations, during which the patient prefers to lie still and resents being disturbed. During these exacerbations it is aggravated by visual or auditory stimulation, or by anything which tends to increase the intracranial tension even for a

short time, such as stooping, running, coughing, or straining. It is frequently increased when the vomiting is most severe, probably for the same reason. The severity of the headache and the frequency and intensity of the exacerbations depend upon the rapidity with which the hydrocephalus develops. When developing suddenly in an adult the pain may be agonizing until some obscuring of the mental faculties appears. When developing in a young child, as in *Cases* 2 and 7, there may be nothing more than a feeling of malaise, sometimes associated with vomiting and vertigo, for a week or more, and then the child is again apparently well. The particular incidence of the acute exacerbations during the night and on awakening in the morning has not, in our experience, been definite enough to be of any value in diagnosis. Russell Brain,[6] however, states that in his cases the headache was especially severe at these times, and explains that this particular incidence is due to the fact that the blood-pressure, and consequently the intracranial pressure, falls during sleep and rises again in the latter part of the night and on awakening.

Vertigo is often associated with the headache, and, in our experience, has been more frequent in the presence of hydrocephalus than of œdema of the brain or circulatory changes complicating intracranial tumour. It is not a true vertigo of the type usually associated with cerebellar or labyrinthine dysfunction. It is rather a light-headedness or a swimming in the head, and is often described by the patient as such. It gives him the feeling that he is uncertain of his position, that he must be careful how he moves his limbs or where he puts his feet if he is to avoid falling; and causes him to look for support when he attempts to move from place to place. Of staggering from side to side, or a tendency to fall in one direction or the other, there is usually little evidence until minor cerebellar symptoms develop as a result of direct pressure from above the tentorium. These symptoms will be discussed at a later stage.

Vomiting is a frequent symptom which also varies with the rapidity of the onset and is subject to exacerbations and remissions. In the adult it is usually most severe at the times when the headache is severe. Russell Brain[6] points out that it may be due to hydrocephalus alone, and, rejecting the explanation that it may be due to pressure on the medulla or to irritation of the vagus, believes it to be a reflex act of which the appropriate stimulus is a rise in the intraventricular tension. The vomiting is apt to be more frequent and more severe when the patient assumes the erect position, but at such times can often be lessened if the change in position is made gradually. It may or may not be preceded by extreme nausea, but it is often more frequent and more severe in those patients who complain of a constant feeling of nausea. It is usually an early and severe symptom of secondary hydrocephalus, and is often of great importance in drawing attention to the onset of the condition. In a young child, however, in whom the skull may adapt itself to the increase in pressure, it may be present for only a short time and then disappear (*see Cases* 2 and 7).

Transient disturbances of vision are generally present. These are usually the appearance of spots in front of the eyes, sudden dimness or transient loss of vision, a blurred outline to objects, and a feeling that a dark wall is shutting the patient in on each side. They are often associated with exacerbations of

the headache and vertigo, and appear on changing the position or on sudden movement. The acuity of the vision is, as a rule, unimpaired at first; but the patient is often unwilling to do anything requiring the use of the eyes, as he feels that it will aggravate his general symptoms.

Mental symptoms of all degrees may appear quite apart from involvement of any particular part of the brain, and are apt to be confused with those which arise as a result of a focal lesion in the frontal lobe. Loss of energy and a constant feeling of fatigue are frequent symptoms in those patients in whom the hydrocephalus has developed slowly (Case 3). There may be mental irritability for a time, but, as a rule, inability to concentrate and to maintain attention are the important features. The memory is often defective, that for recent events is particularly affected, but later the remote memory and the time relations of past events are usually confused. There is increasing inability to carry on an occupation or to attend to any duties, and consequently such patients are often misunderstood or thought to be suffering from a 'nervous breakdown' before the true condition is discovered. Such misunderstanding is apt to arise when the symptoms develop slowly (Case 3), but does not occur when more characteristic symptoms of increased intracranial tension develop rapidly (Case 1). The confusion of hydrocephalus with a lesion of the frontal lobe is often increased by the presence of an unnatural friendliness or a characteristic euphoria on the part of the patient. He may talk easily but wander from one subject to another, may show complete mental detachment, utterly disregard his physical condition, and, far from being disturbed by it, may feel and show others that he is capable of performing even the most difficult tasks. In fact, he may show all the symptoms usually associated with early dementia paralytica. A prominent symptom in one of our patients was a tendency to jocularity in every word that was spoken ; and in two of them an unnatural willingness to have anything done to them as long as it was done quickly. Papilloedema, euphoria, and a steppage gait, all of which disappeared after decompression of the posterior fossa, were associated with dilatation of the ventricles without a tumour of the frontal lobe in a man of 40 referred to by Laignel-Lavastine and Cl. Vincent.[29] In some patients stupor is more obvious, especially when, for the time being, the intracranial tension is above the usual level. In one patient stupor always disappeared on the removal of a small quantity of cerebrospinal fluid, but recurred after sixty hours. As the pressure increases, the patient becomes more stuporose and may sink into a coma.

Generalized convulsions are distinctly unusual in the course of secondary hydrocephalus. They are mentioned by Russell Brain[6] as a symptom of hydrocephalus complicating cerebral tumour. It would appear that, with the increase in intracranial tension, the tendency to the release of function or the irritation of motor cells is lessened rather than increased, and it has been observed in cases of hydrocephalus supervening on a focal lesion characterized by convulsive seizures that the tendency to attacks diminished as the pressure increased. On the other hand, in certain cases, notably that of Gordon,[30] seizures have been present with an increase in pressure, and have become less frequent or disappeared on the relief of pressure.

The temperature is usually regarded as subnormal when the intracranial

tension is increased, but there are many exceptions to this rule. In three patients in whom a sudden increase in intraventricular tension had occurred, one of them following ventriculography, a sudden rise of temperature to 104° was observed, and in none of them could any other cause of the rise be found. It is possible that the rise in temperature in these cases is comparable with that which often follows intraventricular hæmorrhage. In one of our patients an inexplicable symptom was a subjective feeling of chilliness which had been present from the onset of the condition.

The pulse-rate is usually normal, and it is only in the terminal stages when the patient is sinking into coma that a slowing of the rate occurs. The respiration-rate does not appear to be appreciably affected during the active stage of the condition before indications of direct pressure upon the contents of the posterior fossa have appeared.

In short, there appears to be some justification for arriving at the following conclusions about the symptoms as opposed to the physical signs of uncomplicated secondary hydrocephalus : (1) When of sudden onset, the characteristic symptoms of increased intracranial tension appear rapidly in a severe form. (2) When of slow onset, more general symptoms such as those of mental changes may be present and symptoms of increased intracranial tension be less severe. (3) When developing in a young child, minor symptoms may appear for a short time and then disappear as the skull adapts itself to the increased pressure.

In addition to the symptoms, the physical signs of intracranial conditions are varied considerably by the presence of secondary hydrocephalus, and these variations appear not only in the form of alterations in motor power and reflexes, but also in the form of false localizing signs. The former group is best considered in the order in which the variations are encountered in the course of routine physical examination.

In the adult the skull presents no abnormality in shape or size, but occasionally some hyperalgesia of the scalp or tenderness on light percussion of the skull is present. This hyperalgesia is, as a rule, present generally over the vault of the skull, but occasionally it is confined to one side or the other or to the nape of the neck. In the young child the condition of the skull is that seen in the congenital form of hydrocephalus, and there may be great difficulty, apart from the history, in deciding whether a congenital or an acquired condition is responsible for the hydrocephalus (*Case 7*). The skull is enlarged and its circumference may approximate closely to that of the chest even in a child of 4 years, but, owing to the fact that facial structures have had a full opportunity of developing, there is not the same overhanging appearance of the forehead seen in the congenital form. Whether the sutures and fontanelles are affected depends upon the age at which the condition began. In *Case* 2 they were closed, in *Case* 7 they were represented by membranous tissue. The hyperalgesia and tenderness sometimes present in adult cases are usually absent. A cracked-pot sound may be present on percussion if the increase in pressure has been of long enough duration to thin the bones of the cranial vault.

The examination of the eyes presents many features of interest. Defective lateral deviation of the eyeballs may be present on one or both sides

entirely as a result of the general increase in pressure; and, associated with this sign, there may be transient diplopia and slight, irregular jerking movements of the eyeballs on looking to one side or the other at command, but not sufficiently definite to be classed as true nystagmus. The vision is good in the early stages, but when diminished, as it often is as the condition progresses, should lead to the suspicion that optic atrophy is already developing. In the early stages the retinal veins are often distended. The margins of the optic discs may be blurred and papillœdema develops rapidly. In the course of two or three weeks it may reach 5 dioptres and be associated with small hæmorrhages into the retina around the disc margins. If the condition persists or the increased intracranial tension is unrelieved, secondary optic atrophy rapidly develops, with failure of vision, pallor of the optic discs, obliteration of the physical cup, blurred disc margins, increase in pigment around the margins of the discs, and the presence of visible lymphatic sheaths along the vessels close to the disc. The appearance of papillœdema on one side and not on the other, or a greater degree of swelling on one side, does not necessarily indicate that the lateral ventricle on that side is distended more than that on the other side. In connection with this point, however, a comparison of *Cases* 1 and 3 is instructive.

Deafness and tinnitus may be present. There may be noises in the head which the patient describes as like the sound of a waterfall, preventing him hearing properly. Beyond a slight tendency to a lack of expression of the face in repose, the other cranial nerves are usually unaffected. Quite apart from the lack of co-operation due to the impairment of the patient's mental state, all types of sensation may be appreciated somewhat less readily than by the normal individual.

In the absence of evidence of involvement of the motor paths, the muscle tone is often reduced, motor power is slightly decreased, and the tendon reflexes are less active than normal. Cases have been observed in which it was impossible to elicit the tendon reflexes on one side, while on the other they could be elicited only because there was slight involvement of the corresponding pyramidal tract. The plantar reflexes are flexor, or great difficulty is experienced in eliciting any response; occasionally they are found to be extensor. There may be a slight, irregular tremor on one or both sides, but the cause of this sign is not at all evident. The tremor may, however, be confused with that which sometimes occurs with lesions of the frontal lobe, and has been suggested as a useful sign in localization in such cases. Beyond a slight unsteadiness in movement, both with the eyes open and with them closed, co-ordination is usually fairly good.

When the condition is severe and producing mental impairment, or when it has been present for a long time, there may be intermittent or permanent incontinence of fæces and urine. It was particularly noticeable in one case how lack of control of the sphincters appeared as the pressure increased, while complete control resulted as soon as the pressure was relieved.

The more definite false localizing signs which sometimes appear in cases of secondary hydrocephalus have already been referred to in discussing the condition as a factor in localization. The signs which suggest slight involvement of the cerebellum are particularly important, and may occur on one side

more than on the other or equally on the two sides. As a rule, however, these signs are rarely as definite as those which occur with a focal lesion of the cerebellum ; nevertheless they are sufficiently suggestive in a case in which localization depends upon minor indications to be a source of confusion. More definite vertigo is present, the gait is often reeling, and the patient may feel a tendency to fall backwards or to one side. Nystagmus may be more definite, the speech may be slightly slurred, and the muscles of the limbs hypotonic. The motor power in the limbs is decreased, the tendon reflexes are more difficult to elicit, but vary from time to time, there may be some tremor of the hands on movement towards an object, a slight rebound pheno-menon may be present, there may be a suggestion of decomposition of movements, and slight spontaneous deviation of the hands may occasionally be apparent. It will be recognized that, when occurring bilaterally, these signs are simply suggestive of cerebellar dysfunction and no more ; but when occurring on one side more than on the other, it will be obvious that they will lead to difficulties in a case in which one is forced to depend upon minor variations in attempting to localize the lesion. In *Case* 1 they were present more on the left side than on the right. Nystagmus was definite with a long, slow swing to the left, there was a tendency to fall back and to the left, there was a tremor of the left hand on movement, the slight rebound defect was more obvious on the left side than on the right, there was slight spontaneous deviation of the left hand to the left, and the tendon reflexes were more difficult to elicit on the left side than on the right—all signs which suggested, but were not definitely diagnostic of, a lesion of the left side of the cerebellum. As, in this case, the main pontine lesion was very small and did not exert any direct pressure upon the cerebellum, it was evident that the symptoms depended largely upon the secondary hydrocephalus present. There was one feature, however, which may serve to distinguish between primary and secondary cerebellar signs—namely, that the signs varied from day to day and would be definite one day and absent the next, an extreme variability of signs which is not usually observed in true cerebellar lesions.

The mental symptoms which may suggest a lesion of the frontal lobe have already been referred to earlier in this discussion. Minor indications of a pyramidal lesion may appear on one or both sides, and it would seem that they are more likely to arise when the development of the hydrocephalus has been rapid. Some increase in the muscle tone of the limbs may appear together with an increase in the deep reflexes as compared with the normal for the patient. When such slight variations occur more on one side than on the other, or on one side only, it appears that the signs correspond to a greater distension of the lateral ventricle on the opposite side. These signs are com-parable with the general muscular rigidity, sometimes more definite on one side than on the other, which may occur with intraventricular hæmorrhage, and are probably less obvious because of the slower rate of development (*Case* 4). Cases have been seen in which more definite indications, such as inequality of the abdominal reflexes and a transient extensor plantar reflex, were present. The evidences of dyspituitarism developing in the course of secondary hydro-cephalus are particularly interesting, but it is evident that they are liable to occur only in those cases of gradual onset and of comparatively long duration.

2. PUNCTURE METHODS.

The puncture methods which may be employed in the investigation of secondary hydrocephalus are lumbar puncture, ventricular puncture, and ventricular puncture with estimation of the position and volume of the lateral ventricles. Cisternal puncture is rarely, if ever, used, except incidentally, in the investigation of this condition.

As a rule the cerebrospinal fluid withdrawn by lumbar puncture shows no abnormality, but if there is a complete obstruction of the communicating channels between the lateral ventricles and the spinal subarachnoid space, very little fluid may be obtained by this means. In *Case* 1 the cerebrospinal fluid was normal except for the following Lange curve—0021000000. In *Case* 3 the cerebrospinal fluid was again negative and produced the same Lange curve. In *Case* 2 at the first examination there were 4 'small lymphocytes' per c.mm., the Lange test was negative, and the protein was unusually low (0·0075 per cent). At a subsequent examination, there were 8 'small lymphocytes' per c.mm., the protein was again low (0·006 per cent), and there was a slight excess of globulin. On this occasion the Lange curve was the same as that in *Case* 1. In *Case* 6 the cerebrospinal fluid was normal; while in *Case* 4 it was not under pressure, was clear, contained 10 lymphocytes per c.mm., and 0·1 per cent of protein.

Beyond noting that in *Case* 3 the fluid withdrawn from the ventricles showed no increase in cells and was unusually poor in protein, we have had no opportunity of investigating the condition of the fluid withdrawn from the ventricles.

It is possible that direct ventricular puncture with the measurement of the pressure of the fluid in one or both lateral ventricles, and a comparison of the intraventricular pressure with that obtained on lumbar puncture or cisternal puncture, may serve to establish the presence of a block in the circulation of the cerebrospinal fluid between the two ventricles, between the ventricles and the spinal subarachnoid space, or between the ventricles and the cisterna magna. Dandy[31] has employed an ingenious method of ventricular estimation for the localization of brain tumours in comatose patients. He taps both lateral ventricles and estimates their size and position. If both are dilated and they are in communication as shown by indigo-carmine, he concludes that the tumour is in the posterior fossa and explores in that region. If one is dilated and the other collapsed, he explores on the side of the collapsed ventricle.

It is evident, therefore, that, apart from the information to be obtained by ventricular estimation, the examination of a patient suffering from secondary hydrocephalus by puncture methods usually produces evidence of a negative character.

3. X-RAY EXAMINATION.

As a rule in the adult case a skiagram gives little information of value apart from the evidence of increased vascularity in the neighbourhood of a meningeal tumour or endothelioma. In the cases which have begun in early childhood, however, the enlargement of the cranial vault may be confirmed, thinning of the bones of the vault may be noted, the bones may present a

beaten silver appearance, and accentuation of the vascular grooves may be apparent. The last-named feature may also be noted in adult skulls if the intracranial pressure has remained high for a long period.

Certain changes in the base of the skull may be seen in cases of long standing, and especially in those associated with pituitary dysfunction. Decrease in the overhanging clinoid processes, flattening of the sella turcica from above down, and even enlargement of the cavity itself may be present. The possibility that such changes as these may be present in cases of secondary hydrocephalus in association with symptoms of pituitary dysfunction, constriction of the visual fields, and papilloedema is of importance in diagnosis and localization, for a group of findings of this nature is likely to suggest that a lesion of the pituitary gland itself or of the suprasellar region is entirely responsible for the clinical picture, whereas the occurrence of pituitary dysfunction and changes in the sella turcica secondary to hydrocephalus may be overlooked. It would appear that these changes are brought about by direct pressure either from within or without the gland, for the wide dilatation of the infundibulum itself would suggest that pressure may be exerted from within the gland as well as from without.

Irrespective of the relation of intracranial tumours to secondary hydrocephalus, Cairns[32] has pointed out the value of X-ray examination in the diagnosis and localization of such tumours. The presence of calcification in 71 per cent of craniopharyngeal pouch cysts according to McKenzie and Sosman,[33] the positive radiological findings in 'meningiomata' described by Sosman and Putnam,[34] evidence of calcification in 10 per cent of gliomata according to Van Dessel,[35] and evidence of displacement of the falx cerebri or of the pineal body to one side of the middle line by noting the position of shadows of calcified areas in one or the other, show how X-ray examination may be of considerable value in the diagnosis and localization of the lesions giving rise to secondary hydrocephalus.

4. VENTRICULOGRAPHY.

Having reached the stage in the investigation of a case in which a tumour is suspected to be present and possibly complicated by secondary hydrocephalus, it is necessary to decide whether ventriculography should be employed to confirm the diagnosis and, if possible, to localize the responsible lesion. This resolves itself into the consideration of the indications for and against employing the method, the technique of the method to be used, the sites of puncture, the positions in which the head is to be photographed, and the interpretation of the films themselves.

It cannot be denied that this method of examination exposes the patient to certain risks, and these must be carefully considered and weighed against the condition of the patient and the value of the information that may be gained. In *Case* 2, towards the end of the operation, the breathing became stertorous, vomiting occurred, and the patient went into coma ; she recovered after the further withdrawal of a small quantity of cerebrospinal fluid, was apparently normal though somewhat drowsy for four hours, then became cyanosed and died suddenly. Though it was apparent from the condition of the patient that sudden death might have occurred at any time, it cannot

be doubted that the operation contributed to her death. In another case. about three hours after the operation, the patient complained of severe head-ache and vomited frequently, the temperature rose rapidly, and retention of urine necessitating catheterization occurred. It was only after the use of methods directed towards the temporary relief of increased intracranial tension that this patient's condition returned to normal. In the 392 cases collected by Grant[10] death was directly attributable to ventriculography in 32 cases. Of the 37 cases investigated by ventriculography in Cushing's clinic and referred to by Cairns,[32] 2 died as a direct result of this procedure, and serious symptoms were produced in a third. In one case urgent symptoms appeared one and a half hours after the operation as a result of a great increase in the intracranial pressure, and in another serious symptoms appeared only at the end of three days. Penfield[9] reported a case in which severe headache followed by sudden death occurred thirty-six hours after the operation in a patient in whom the ventriculogram had shown the presence of secondary hydrocephalus. Bingel[8] collected the reports of 6 cases of death following the introduction of air by the spinal route, and of 3 cases in which the ventricular route had been employed. In 7 of these cases there had been ventricular block, in 5 as the result of a tumour above the tentorium, and in 2 owing to a subtentorial tumour. In 2 of Denk's[36] cases included in the above series air was introduced by the lumbar route and death occurred after a long interval.

· Penfield[9] has discussed the dangers of ventriculography other than the risk of sudden death or of death at an interval after the operation. In 50 per cent of his cases there occurred a moderate febrile reaction, consisting of a rise of temperature within twenty-four hours and lasting up to four days. Increased intracranial tension with vomiting, drowsiness, and increased head-ache for as long as one week were present in some cases. Vomiting and rapid coma persisting for one hour supervened in one case in which the lumbar route was employed, and was thought to be due to the collection of air in the subarachnoid space and around the medulla. Penfield mentioned that this type of reaction did not occur in cases in which the ventricular route was employed, but our Case 2 provides an example of this reaction under those circumstances. Coma and convulsions occurred in one case and disappeared in four hours after the removal of the air from the ventricles. Frequently. staining of the cerebrospinal fluid with blood was noted towards the end of the operation, probably as the result of a meningeal reaction. This reaction was also mentioned by Hermann[37] and by Mader.[38] The former found 18,000 and 11,000 cells in the fluid at the time of a second puncture, and the latter noted that with successive withdrawals of fluid the percentage of lymphocytes steadily increased. Penfield reported one remarkable case of infection of the ventricles during the operation. Herniation of the cerebellum into the foramen magnum was particularly apt to occur if an increase in intracranial tension was already present; and bulbar paralysis, coming on quickly and disappearing in a short time, was liable to occur especially when the lumbar route was employed. A slow increase in intracranial pressure with vomiting. headache, and drowsiness occurred in some cases in which the ventricular route was employed, but in such cases sudden death might result. Penfield

pointed out that, in the presence of ventricular block, an increase in the intra-ventricular pressure usually occurred an hour or two hours after the puncture and the introduction of air, and the pressure had been found to be definitely higher at the time of a second puncture than when the injection was just finished. He suggested that this post-operative increase in pressure might be due either to the irritating action of the air or to the sudden reduction of pressure during the operation stimulating an increased production of cerebro-spinal fluid. In 20 infants in whom air was injected by the lumbar route Mader[38] observed a constant reaction—the child cried, then became quiet and pale, vomiting and changes in the pulse occurred, and in the more severe cases respiration ceased.

From the consideration of these reactions following ventriculography, it will be obvious that they are sufficiently frequent and severe to suggest that this method of examination should be used only when a definite diagnosis and localization is not possible by other means. The clinical results of diagnosis and localization vary with different individuals and the necessity for ventriculography varies in consequence. It is equally obvious, however, from Grant's figures that it should be used without hesitation in those cases in which the general symptoms are definite, not only to determine the size and position of the ventricles and to determine the presence or absence of a tumour, but also to decide whether exploration or an attempt at surgical removal is likely to meet with success. It definitely increases the proportion of cases of intracranial tumour in which surgical intervention is possible, and at the same time reduces the number of negative explorations. In some quarters, however, ventricular estimation according to the method recommended by Dandy[31] is preferred to ventriculography as being the safer procedure.

Certain procedures have been recommended for dealing with the reactions which are apt to follow ventricular puncture and ventriculography. Of these, the most practicable appear to be the following : (1) The replacement of cerebrospinal fluid by air should be carried out gradually and with only gradual alterations in pressure—that is, the fluid should be withdrawn in very small amounts and replaced with air at each stage. (2) If an unfavourable reaction should occur during the operation, the air should be removed and replaced by Ringer's solution or the previously removed cerebrospinal fluid. As, however, dangerous reactions are liable to occur when a large quantity of fluid is still present. it may be possible only to remove a further small quantity of fluid in an attempt to relieve the symptoms. (3) As the air injected can always occupy a larger volume than the fluid removed, the volume of air injected should always be less than that of the fluid removed. (4) When ventricular block has been shown to be present, it is necessary to anticipate the subsequent rise of pressure within the ventricles by the use of hypertonic saline intravenously, or a saline cathartic by the mouth or rectum. (5) In cases in which ventricular block is suspected the patient may be subjected to decompression immediately the condition is diagnosed and within two hours of the injection of air into the ventricles. The decom-pression operation may be carried out either as an operation in itself or as the first stage of a subsequent attempt at removal if the case is suitable.

According to Grant, early operation will remove the risk of all the severe after-effects of ventriculography.

The choice of the method to be employed in injecting air for ventriculography in cases of suspected secondary hydrocephalus needs some consideration, and resolves itself into a discussion of the relative advantages and disadvantages of the direct ventricular and of the lumbar route. Of the latter method we have had no experience, but reference to the literature on the subject would appear to point to a very definite choice between the two procedures. According to Penfield,[9] bulbar paralysis, a slow increase in pressure resulting in sudden death, and herniation of the cerebellum into the foramen magnum are more liable to take place when the lumbar route is used. According to Mader,[38] the injection of air by the lumbar route in infants resulted in severe reactions in every case, and in death in one case; whence it was concluded that the spinal route should be used only with great care. Of the nine deaths after ventriculography recorded by Bingel,[8] six occurred after lumbar injection. Denk's[36] three fatal cases were all the result of injection of air by the lumbar route, whereas he had carried out thirty injections by the ventricular route without any serious difficulty. Denk concluded therefore that the injection of air by the lumbar route was never justified in the presence of increased pressure unless preceded by a ventricular decompressive puncture. Jacobaeus[21] apparently favoured the ventricular route in preference to the lumbar route, recognized that it was probably of more value in diagnosis, and drew attention to the possible use of cerebral puncture as a therapeutic agent. Waggoner,[39] basing his opinion on an analysis of ten cases, preferred the spinal route for the purpose of obtaining a roentgengraphic record of the ventricles, cisternæ, and the subarachnoid spaces, and pointed out that it was particularly valuable in the differentiation of the obstructive and communicating types of hydrocephalus.

Opinions differ as to the most suitable site for ventricular puncture. Grant[40] recommends that the site of puncture should be 7 cm. above the occipital protuberance and 1·5 cm. lateral to the middle line, and claims that this site has the following advantages : (1) The site of puncture allows the needle to pass through a silent area of the brain. (2) A puncture at this site permits a direct approach to the vestibule of the lateral ventricle, which is its widest part and that least likely to be collapsed. (3) With the head back, efficient drainage of the ventricles can be obtained. Dandy recommends the occipital route in order to avoid the possibility of hæmorrhage into a cerebral tumour, as a tumour in that region can be ruled out by a careful chart of the visual fields. Others again advise puncture of the inferior horn of the lateral ventricle through an opening 1·5 in. above Reid's base line and the same distance behind the external auditory meatus.

According to the majority of writers, the most important factor for success in ventriculography is the removal of all fluid ; but equal stress is laid upon the removal of the fluid and the replacement with air in small amounts at a time, and upon the introduction of a volume of air less than that of the fluid removed. It is essential that antero-posterior, postero-anterior, right lateral, and left lateral skiagrams should be taken, and if possible

stereoscopic skiagrams. Great care must be exercised to keep the head perfectly still while the exposure is being made if a good outline of the ventricular system is to be obtained. In the antero-posterior skiagrams it is essential that the head is kept absolutely in the middle line, otherwise some distortion of one or other ventricles may occur and false deductions be made.

In the interpretation of the ventriculograms much experience of both the normal and abnormal features of the ventricles is needed. Normal variations are not at all uncommon, especially in the lateral ventricles, as has been shown by Penfield.[9]

In general, intracranial tumours produce either symmetrical or asymmetrical variations in the position, shape, and size of the ventricles. The asymmetrical variations are due either to a tumour within the cerebral hemisphere and lateral to the middle line, or to direct impingement of a tumour on the lateral ventricle, and not to obstruction of or interference with the free circulation of the cerebrospinal fluid. Tumours in the region of the foramen of Monro may be partially or completely blocking that opening, and a unilateral hydrocephalus may be produced which can readily be demonstrated in an antero-posterior skiagram. Tumours in the occipital lobe may obliterate the descending horn of the lateral ventricle, evidence of which can be seen in a lateral skiagram, especially if stereoscopic views be taken. In the same way large tumours of the frontal lobe may exert enough pressure almost to obliterate the descending horn of the lateral ventricle, and so produce an irregularity in the outline of a lateral skiagram. As a general rule it may be said that asymmetry of the lateral ventricles is strong evidence of a cerebral tumour on the side of the small ventricle.

Excepting for the rare cases in which a tumour of the midbrain obstructs the outflow of cerebrospinal fluid from one lateral ventricle to a less extent than from the other, obstruction of the free circulation of the cerebrospinal fluid usually results in a more or less symmetrical dilatation of the two lateral ventricles, and may be produced by a tumour in the mid-line between the two hemispheres, by one involving the foramen of Monro or the third ventricle, or by one blocking the outflow of fluid in the aqueduct of Sylvius, the fourth ventricle, or the cistern. If it be accepted that a subtentorial decompression is essential in the case of subtentorial tumours—a question which will be discussed at a later stage—it is necessary to differentiate carefully between a supratentorial and a subtentorial tumour in the region of the third ventricle. It has been suggested that two useful points of differentiation are the following : (1) If the third ventricle can be seen, the block is below the tentorium ; and (2) A subtentorial tumour to one side of the middle line may impinge upon the posterior horn of the lateral ventricle and distort it. Elsberg and Silbert[41] have added the following interesting point of differentiation : that a block above the tentorium distends the anterior and inferior horns of the lateral ventricle equally, whereas one below the tentorium distends the former more than the latter.

Generally it is found that the antero-posterior and postero-anterior views are the most valuable, but in arriving at a conclusion on the ventriculograms it is essential to consider only the defects which are present in all the views, and to correlate the results with the clinical findings.

In some cases there can be no doubt that ventricular estimation may take the place of ventriculography, and it is a safer procedure. In this operation the lateral ventricles are tapped and the amount of fluid withdrawn from each is noted. Any amount over 30 c.c. points to a condition of hydrocephalus, and if the amounts from the two ventricles are not the same it is strong evidence of a tumour above the tentorium.

5. OBSERVATIONS AT THE TIME OF OPERATION.

Observations made at the time of operation, and especially in the course of operation for mobilization of the tentorium, are useful in confirming a diagnosis of secondary hydrocephalus. The cerebral hemispheres are found to be tense and firm to palpation, the gyri are flattened, and the superficial veins are distended. If the pressure is high, the dura and the brain tissue are forced into the wound on removing the bone-flap. Distension on one side more than on the other may help to localize the cause of the obstruction in the midbrain or between the two cerebral hemispheres, obstructing the circulation of fluid from one lateral ventricle more than from the other; while a collapse of the ventricle on one side associated with dilatation on the other side suggests a tumour involving the cerebral hemisphere on the collapsed side. Equal distension of the two ventricles suggests that a midbrain tumour has obstructed both foramina of Monro, or that the tumour causing the block is at a lower level.

In addition, observations of the tenseness of the cerebral hemispheres during lumbar puncture after the bone-flap has been removed may show that no decrease in pressure occurs with the removal of fluid from the spinal canal, and confirm the opinion that a block exists in the hindbrain.

IX. THE TREATMENT OF SECONDARY HYDROCEPHALUS.

The effect of the presence of secondary hydrocephalus upon the treatment to be employed would appear to be the following. Measures designed to facilitate the absorption of cerebrospinal fluid, such as the intravenous injection of hypertonic saline solution or the use of magnesium sulphate by the mouth or the rectum, may be necessary as a preliminary step. We must state, however, that we have never seen any prolonged benefit from repeated enemata of concentrated magnesium sulphate, nor from the use of hypertonic saline intravenously. These measures have been used successfully to carry a patient over the danger period, such as that due to the sudden increase in intracranial pressure after ventriculography.

Following such preliminary urgent treatment, surgical methods of relieving the increased intracranial tension are necessary. Repeated ventricular puncture may be considered, but it would appear that this method is likely to be of value only in those cases in which time is necessary for a local inflammatory or obstructive lesion to recover. It was used successfully in a case reported by Gordon.[30]

When surgical decompression is considered, it has to be decided whether decompression above or below the tentorium should be employed, even when there are some indications that the cause of the blockage is in the posterior

fossa of the skull. Each case has to be considered on its merits, but the balance of evidence would appear to be in favour of a supratentorial decompression in association with exploration of the posterior fossa. The general principle would appear to be to attack general symptoms above the tentorium and only definite localizing symptoms below the tentorium, and, when necessary, to combine both objects in one operation.

The treatment of secondary hydrocephalus is, therefore, the removal of the tumour wherever possible, but this is rarely possible, more particularly when the tumour cannot be localized. The treatment where the tumour cannot be removed is simply that of decompression. The intermusculo-temporal decompression gives quite good results and considerable temporary relief. For cases in which the tumour is subtentorial the best results are obtained by turning down an osteoplastic flap, and exposing the occipital lobes and the cerebellar hemispheres by means of Souttar's craniotome. The constriction of the tentorium at once becomes loose, as the tentorium no longer has its bony attachment behind the occipital bone.

X. SUMMARY AND CONCLUSIONS.

1. The influence of secondary hydrocephalus upon the diagnosis and localization of intracranial tumours is discussed, and the methods of investigation and treatment are detailed.

2. The different views propounded to explain the occurrence of hydrocephalus in the course of intracranial tumours are reviewed.

3. Seven cases of intracranial tumour complicated by secondary hydrocephalus are described to illustrate the difficulties in diagnosis and localization in the presence of secondary hydrocephalus.

4. The differential diagnosis of intracranial tumour complicated by secondary hydrocephalus is discussed.

5. Secondary hydrocephalus as a source of confusion in localization is considered ; attention is drawn to the false localizing signs which may appear as a result of that condition ; and stress is laid upon the chronological order of the physical signs.

6. The investigation of a case of secondary hydrocephalus is discussed ; the clinical features of the condition are described, and the value of puncture methods, X-ray examination, ventriculography, and observations at the time of operation are considered.

7. Ventriculography should be employed in the investigation of a case only when all other methods of examination have failed to establish a diagnosis and to localize the lesion ; and, in carrying out this procedure, ventricular puncture is to be preferred to spinal puncture.

8. In view of the questions raised in this paper, the treatment of secondary hydrocephalus should be instituted as early as possible commensurate with thorough investigation of the patient. It should provide for the relief of pressure above the tentorium even when the local lesion is situated in the posterior fossa of the skull—a result which is best achieved, when symptoms of a subtentorial lesion are present, by the operation for mobilization of the tentorium, as has been amply illustrated by some of Souttar's cases.

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VOLKMANN'S ISCHÆMIC CONTRACTURE TREATED BY TRANSPLANTATION OF THE INTERNAL EPICONDYLE.

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IN the BRITISH JOURNAL OF SURGERY, October, 1928, Hamilton Bailey recorded a case of Volkmann's ischæmic contracture treated by the transplantation of the internal epicondyle of the humerus. Stimulated by this
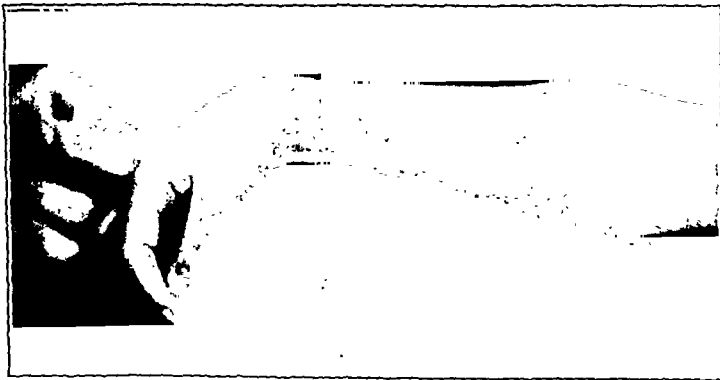
FIG. 171.

FIG. 172

article I determined to try the operation in a case which had hitherto resisted all efforts to overcome the contracture, and the result has far exceeded my expectations.

The case was one of a girl, age 14, who some eight years previously had sustained a fracture of the lower end of the right humerus. The method by which the fracture was treated could not be ascertained. When first seen four years ago she had a typical Volkmann's contracture. Gradual extension of the wrist, massage, and movement were tried over a long period, but the improvement made was negligible.

Figs. 171 and 172, made before the operation, show the flexion of the fingers when an attempt was made to extend the wrist, and that the fingers could only be extended by fully flexing the wrist.

FIG. 173.

In November, 1928, I carried out the operation on the lines described by Hamilton Bailey. My experience follows his exactly ; there was no dramatic relief of the contracture, but at the end of three weeks there was an appreciable improvement in the amount of extension obtainable. Massage and movement are being continued, together with gradual extension of the wrist on a 'cock-up' splint.

Fig. 173 shows the condition of the hand on Jan. 31, 1929. The patient has now good use of the fingers and wrist, and what was previously practically a useless member is now a useful limb. I hope that in the course of time still further extension of the wrist will be possible.

A FURTHER NOTE ON KÜMMELL'S DISEASE.

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As a sequel to our previous article on Kümmell's disease[1] we wish to place on record the pathological findings subsequently ascertained in one of the cases therein recorded. The present photograph (*Fig.* 174) refers to *Case* 7 in our previous account.

In March, 1925, he was kneeling, and was struck on the back by a falling stone. He was kept in bed for several weeks on account of pain and shock. X-ray examination at this time revealed no bony spinal lesion at the site of the injury. In the summer of 1925 he was up and about, much relieved, but still ⸺ ⸺ : ⸺ ual soreness. He could walk abou ⸺ ⸺ ⸺ . In October he complained of a great exacerbation of the dorsal pain. His back became very painful when he walked. Examination revealed several healed abrasions on the back and a kyphosis at the dorsilumbar junction. There was considerable local tenderness with much pain and limitation of movement at the level of the 1st lumbar vertebra. X-ray examination showed that this vertebral body was collapsed and had assumed a wedge shape typical of Kümmell's disease. The patient was thereupon fitted with a jacket giving spinal support. His symptoms regressed and his spinal lesion became stationary. In April, 1926, insanity, not relevant to Kümmell's disease, supervened and he was certified and removed to an asylum. Here his spinal lesion remained stationary for two years, and finally the spinal jacket became quite unnecessary, though the patient would never part with it.
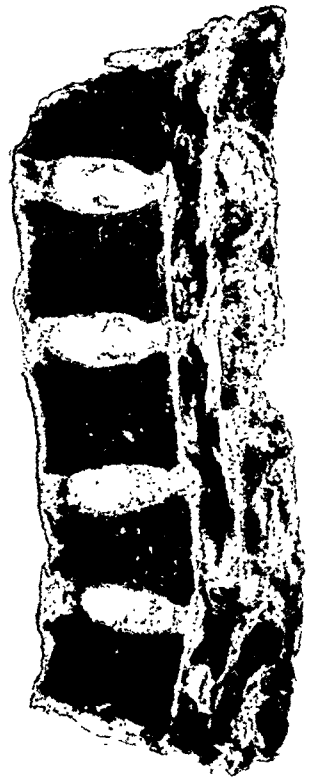
FIG. 174.

Sequel.—In September, 1928, the patient died, and by the courtesy of Professor Shaw Bolton his dorsilumbar spine was added to the collection of similar specimens in the Pathological Museum of the Leeds School of Medicine. The photograph (*Fig.* 174), which we think calls for no comment, shows the typical wedge-shape deformity and collapse of the 1st lumbar vertebra.

Recent authoritative literature,[2] notably from the original pen, has stabilized Kümmell's disease as a clinical entity. We do not propose to recapitulate our former article, but we would like to emphasize in the above case the characteristic salient features of the malady. The full sequence is : (1) An injury, direct or indirect, grave or trifling, to a vertebral body ; (2) A

period of disability according to the gravity of the trauma; (3) A latent period; (4) A recurrence of local pain and severe disability due to (5) A crumpling collapse of a selected vertebral body, and its assumption of a wedge shape as seen in sagittal section; (6) The arrest of the process by orthopædic support.

We are again indebted to Professor Maxwell Telling for permission to record this case.

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ON THE TRANSFUSION OF CITRATED OR DEFIBRINATED BLOOD THROUGH A FINE NEEDLE.

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BLOOD transfusion has developed from an emergency operation, confined to the operating theatre, into a routine mode of medication, which often has to be repeated at frequent intervals and be performed either in the ward of a hospital or at the home of the patient. Although many methods have been devised during the last ten years, there is yet a demand for a simple and reliable procedure which can be carried out at the bedside, without much assistance, with minimum discomfort both to the donor and to the recipient, and with success.

One of the first difficulties in performing a blood transfusion is to find a suitable donor. Now that the glamour of giving one's blood to a patient has largely died out, owing to the fact that blood transfusion is often used not as a desperate effort to save life but as a remedial measure, voluntary donors who are not related to the patient, and even professional donors, demand that no incision be made which needs sutures and subsequent dressings and which will leave a scar on the arm. The use of a needle, even of large bore, on the other hand, has proved to be unsatisfactory in many cases, as the flow of blood is never as good as when using a cannula; the flow may slow down after the first 200 to 300 c.c. and the blood may clot inside the needle, thus preventing any further collection of blood unless another vein is tapped with a fresh needle.

Dr. Herbert French has devised a 'needle' which is a cross between a cannula and an ordinary needle, having a point with three facets like a bayonet and a stem made to a conical shape so that the bore at the base is considerably greater than at the point. The needle is so sharp that it will pierce the skin like butter, it is easily introduced into a vein, and it ensures a splendid flow of blood, without risk of clotting. French's needle (*Fig.* 175 B) is connected directly to the jar for collecting blood (A) by thick rubber tubing which cannot kink, and there are no metal or glass connections between to cause friction or to hold up the flow of blood along its course, as the rubber tubing is threaded straight through the rubber bung of the jar. The blood flows by gravity, and it is neither necessary nor advisable to produce a vacuum inside the jar, as this tends to hinder the flow by collapsing the vein. There is no risk of contaminating the blood by holding the jar below the donor's arm, as the jar is closed by a rubber bung. A pint or more of blood is thus quickly drawn off, and on withdrawing the needle the small triangular wound like a leech bite soon closes and stops bleeding on lifting the arm above the head for a few minutes. There is no incision, no injury

to the vein, and the same vein may be used repeatedly for subsequent transfusions. It is not advisable, however, to use a donor more than twice for the same patient, as the recipient becomes as it were sensitized to the blood.

The use of sodium citrate as an anticoagulant is the easiest way of transfusing blood, although it is not always harmless. Mellon[1] has shown the variability of the chemical reaction of commercial sodium citrate, and there is probably also an individual variation in the tolerance of different people.
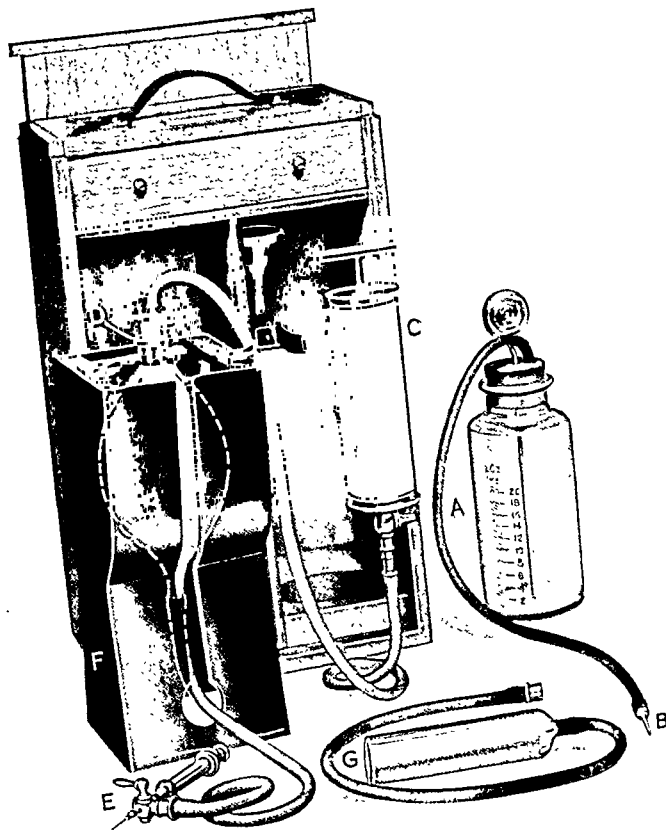
FIG. 175.—Diagram of the apparatus. A, Graduated jar for collecting blood. The graduations are both in ounces and cubic centimetres. The curved rod is used for defibrinating the blood; B, French's needle; C, Pump; D, Reservoir containing blood after having been citrated or defibrinated and filtered; E, Two-way stop-cock with hypodermic syringe, needle, and tube from reservoir, all attached in readiness for use; F, Heating stand with two hot-water tanks on either side of the reservoir. The reservoir may be taken out of the stand; G, Saline infusor.

Lederer[2] and others claim that the addition of sodium citrate increases the incidence of reactions. This drug, however, is not the only factor in producing a post-transfusion reaction. The reaction may in some cases be anaphylactic, due to some sensitive protein in the donor's blood, or it may be caused by slight incompatibility, especially when stock grouping rather than direct testing of the donor's and recipient's blood is relied upon; lastly

it may be due to incipient coagulative changes if the blood is not drawn off quickly enough and well filtered. Keynes,[3] while admitting the possible influence of citrated transfusions in causing reactions, regards their occurrence as of little importance and as greatly overweighed by the advantages of the method.

In view of these objections which may be made to the citrate method, the collecting jar (*Fig.* 175 A) in my apparatus has been adapted also for the defibrination method. When using the defibrination method, Skinner[4] has recommended the use of a special curved rod, which is inserted into the rubber bung with its curled end pointing downwards and touching the bottom of the jar. The jar is kept in a continuous rotary motion during the whole time the blood is being collected and for at least five minutes afterwards. Fibrin will collect in a lump on the curled end of the rod and can then be removed.

If the citrate method is used, the required amount of a freshly prepared and sterile solution of sodium citrate is poured into the collecting jar, and the central rod is inserted with its curled end pointing upwards. Opinions differ as to the strength of the solution to be used. I use the smallest amount of citrate sufficient to prevent clotting, or 10 c.c. of a 2 per cent solution to every 90 c.c. of blood, although some writers favour larger doses. Robertson[5] recommends 160 c.c. of a 3·8 per cent solution for 750 c.c. of blood as it gives an isotonic solution. Spriggs[6] uses a 4 per cent solution, of which 100 c.c. are added to each 500 c.c. of blood.

The citrated or defibrinated blood is decanted from the collecting jar (A) into the reservoir (D) and at the same time it is strained through two layers of gauze or cheese cloth. Prior to pouring the blood into the reservoir a small amount of normal saline is made to flow through the rubber tubing, the two-way stop-cock (*Fig.* 175 E and *Fig.* 176) and needle, in order to expel any air contained therein.

The reservoir (D) is placed in a heating stand (F) provided with two water tanks on either side to keep the blood warm. A chief difficulty in performing a blood transfusion is to deliver the blood to the recipient. The cannula method entails dissecting a vein to the discomfort of the patient, while if a needle of moderate bore is used, as suggested by methods described heretofore, there is always some anxiety in introducing the needle into the vein when the vein is small or contracted. In gravely exsanguinated or nervous patients the vein may be spastically contracted so as to make it impossible for the blood to flow into the vein after the needle has been inserted. In order to overcome these difficulties, I have introduced the use of very fine intravenous needles (size 21 Standard Wire Gauge), and this has been made possible by a specially devised pear-shaped container (D), a strong pump (C), and a two-way stop-cock (E). The pear-shaped container is connected to a pump, and the mouth of the container is closed by a rubber stopper which can be firmly fixed by two screw clips. By using a reservoir of this shape, practically all the blood can be pumped out under great pressure without any risk of blowing air into the vein. The pump is made to the same design as that used in a Potain's aspirator, but is three times larger and will enable blood to be pumped through a very fine needle.

Lastly a two-way stop-cock (*Fig.* 175 E and *Fig.* 176) has been devised which so simplifies the technique of delivering the blood to the recipient that this may be done as easily and with as little discomfort to the patient as any ordinary intravenous injection. To it an ordinary hypodermic syringe, a needle, and the tubing leading from the reservoir are attached. The tap of the stop-cock can be turned in such a way as to have either the syringe and needle communicating (*Fig.* 176 *a*), or the syringe cut off and the needle communicating with the tube from the reservoir (*Fig.* 176 *b*). With the tap turned to *a*, the operator introduces the needle into the vein, draws some of the recipient's blood into the syringe to ensure that the needle has been correctly inserted, thereupon turns the tap round to *b*, and rapidly connects the needle to the reservoir. In this way one eliminates the tedious procedure
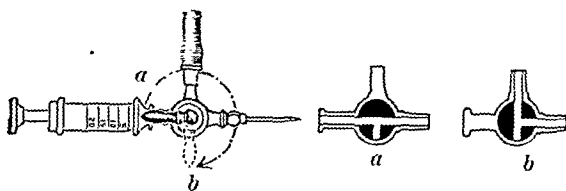
FIG. 176.—Diagram of the two-way stop-cock. *a.* The needle and syringe are communicating. *b.* The tube leading from the reservoir (*Fig.* 175 E) is now connected with the needle.

of fitting the tube on to the needle after the vein has been punctured, which often entails spilling of blood and a risk of air embolism, and the whole operation of inserting the needle and connecting it with the transfusion set is made perfectly easy and fool-proof. When the reservoir is nearly empty the tap of the stop-cock is turned back to *a*, thus shutting off the reservoir, and the needle is withdrawn from the vein. The small amount of blood left in the stem of the reservoir and in the rubber tubing is a sufficient safeguard against air being injected into the vein. It is not possible to overlook the fact that the reservoir has been emptied, as the heating stand has a slit-window exposing the whole length of the reservoir, and the flow of blood can be easily watched.

TECHNIQUE.

To Collect the Blood.—Pour the required amount of sterile 2 per cent solution of sodium citrate into the collecting jar. Place a sphygmomanometer armlet round the donor's arm, raise the pressure to 80, and instruct the donor to clasp and unclasp his fist alternately. With a quick jab introduce French's needle into a vein (median basilic or median cephalic) and allow the blood to flow into the jar by gravity.

When using the defibrination method insert the metal rod with its spiral end pointing downwards touching the bottom of the jar, and do not add any citrate. During the whole time the blood is being collected the bottle is kept constantly revolving gently, thereby swinging the blood content against the spiral. As soon as sufficient blood is obtained the needle is withdrawn and the bottle continuously rotated for about six minutes, at the end of which time the cork is removed; a large single clot of fibrin will be found adhering to the spiral. Before pouring the citrated or defibrinated blood into the reservoir precede with some sterile saline to expel any air in the rubber connections, and while decanting the blood from one jar to the other strain the blood through gauze or cheese cloth. Place the reservoir in the heating stand to keep the blood warm.

To Deliver the Blood.—Place a bandage round the recipient's arm so that it can be easily loosened as soon as the vein has been punctured. With the tap of the stop-cock turned to *a*, introduce the needle into a vein and draw some blood into the hypodermic syringe ; if blood flows freely into the syringe it is sufficient proof that the needle has been correctly inserted. Turn the tap to *b*, thereby connecting the needle to the reservoir, loosen the bandage, start to pump, and blood will begin to flow into the vein. When the reservoir is nearly empty turn the tap back to *a* and withdraw the needle from the vein. It takes ten to twenty minutes to deliver a pint of blood, but if necessary the blood can be injected much more slowly.

The apparatus has been thoroughly tested in a large number of blood transfusions over a period of three years and can be strongly recommended. The technique is extremely simple and does not require any operative skill. The apparatus can be easily cleaned and sterilized and the whole set is obtained in a convenient box for carrying it. The transfusion set includes also a saline infusor composed of a cylindrical glass funnel with rubber tubing (*Fig.* 175 G) which can be connected to the two-way stop-cock and needle. The same procedure is followed as described for delivering blood, except that saline is poured into the funnel and allowed to flow into the vein by gravity. The saline infusor may be used for intravenous injection of normal saline, glucose, etc. The whole of my own apparatus, as described above, may be obtained from Messrs. Reynolds & Branson Ltd., of Leeds.

SUMMARY.

Difficulties arising from other methods of blood transfusion, described heretofore, afford a sufficient excuse for devising yet another apparatus having the following advantages :—

1. A very fine intravenous needle (size 21, I.S.W.G.) can be used for delivering blood to the recipient.

2. The operation of inserting the needle into the vein is simplified by a two-way stop-cock enabling the operator to ensure that the needle is correctly placed inside the vein and rapidly to connect the needle with the transfusion set by the mere turn of a tap.

3. There is no risk of clotting.

4. Either the citrate or the defibrination method may be used.

5. Blood transfusion can be carried out at the bedside, as there is very little need for asepsis.

6. Blood is kept warm in a heating stand.

7. The technique is extremely simple, does not require any operative skill. and ensures success every time.

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THE RADIUM PROBLEM.

I. INTRODUCTORY.

By Professor G. E. GASK, C.M.G., London.

The interest of the world of medicine and of the public at large has been stirred by the advances made in the last few years in the treatment of malignant disease by radium. The subject is of such pressing national importance that in April of this year the Radium Sub-Committee of the Committee of Civil Research issued a report on radium in the treatment of cancer, and the Government promised to make a grant of £1 for every £1 subscribed by the public for the establishment of a National Radium Fund, and this now amounts to a large sum. The ready response of the public to this appeal shows its practical interest, and it has been decided that the public contribution shall form part of the Thank-offering Fund for the King's convalescence. Subsequently two bodies were founded to deal with the fund—namely, the National Radium Trust and the National Radium Commission. As the result of this National Fund it is hoped that a large supply of radium will be forthcoming for the use of the medical profession in its campaign against cancer. It is well, therefore, that a survey should be made to consider the present position of radium in the treatment of malignant disease in order to assess its proper value, without either taking an exaggerated view of its therapeutic properties or underrating them.

It has been known for many years that radium has a powerful effect on various affections of the skin, and that rodent ulcer and superficial epitheliomata can often be completely and permanently cured by its use in surface applicators. During the last few years the technique of radium therapy has been elaborated and greatly improved by the use of radium needles, or of seeds containing radium emanation or radon, which are buried in the tissues in or around the growth. Most of the work done in this country has been directed towards the treatment of cancer of the cervix uteri, the rectum, the breast, and the tongue and buccal cavity. These areas have been selected by the various Research Centres, because in these situations growths are easily accessible and the effects of the radium can be seen and judged, whereas in internal cancers it is much more difficult to watch the effect of treatment. It can be stated definitely that in the above-mentioned areas, as the result of long and hard work, of many trials and many errors. a big step forward has been made. In many cases carcinomata of the cervix, breast, rectum, and mouth have entirely disappeared, and the patients remain well and apparently free from disease for several years.

It is astounding—indeed, almost miraculous—to observe the manner in which in a successful case a malignant growth fades and disappears. In one instance a well-marked epitheliomatous ulcer of the tongue disappeared and skinned over in the space of three weeks from the commencement of treatment. The nearest comparison that can be made is the manner in which a gummatous ulcer on the skin heals in a few weeks under appropriate treatment. This makes one wonder what is the action of radium on the growth. Does it kill the cancer cells? One has seen the effect on the cells in Canti's film. Or does it kill the virus or active agent of cancer? There is as yet no answer to this intriguing question.

Remarkable as are the results already obtained, we must not allow ourselves to run away with the idea that radium is the cure for all cancers, for the problem is not an easy one. The attack on the primary growth is, in a sense, the easiest part of the task, for if the growth is accessible, if the radium is implanted in the right place, if the whole of the tumour is irradiated, if the dose is correct, and if the exposure is rightly timed, then one may expect the shrinkage and disappearance of the tumour. In the course of the work one point that has come out quite clearly is that destruction of a primary growth, followed by its complete disappearance, does not in any way affect the growth and extension of metastases, if these are already formed, any more than excision of a carcinoma of the breast by the knife will cure a patient if there are secondary deposits in the viscera. Radium therapy, if it is to be successful, must aim at destroying not only the primary growth, but also any extensions which may have formed in the neighbouring lymphatic glands. We must emphasize again the fact that treatment of cancer, if it is to be successful, whether it takes the form of surgical excision, the cautery, radium, or X rays, must be undertaken early, before dissemination has occurred ; and it must be reiterated that an essential part of the campaign against cancer consists in the education and intelligent co-operation of the public so that early diagnosis and early treatment may be secured. Already something has been done in the direction of irradiating the lymphatic drainage area at the same time as the primary growth, as will be seen in the succeeding articles, and the prospects of improving this line of treatment appear to be good.

If one turns now to consider what is the relative value of radium therapy in the treatment of cancer as compared with surgical excision, it will be found a difficult point to assess, for the reason that there are not yet sufficient facts available. In the first place most of the available data concern cancer only of the areas of the body above mentioned, and secondly we have not yet a sufficient number of cases, nor has sufficient time elapsed, to prepare statistics which will show a true picture. The great point in favour of the use of radium is that the effect can be obtained without the extensive and mutilating operations which are at the same time so distressing to the patient and to the surgeon. The operation of introducing the radium is in itself a comparatively slight one, not fraught with any immediate danger, and while the radium is in position the patient suffers little or no discomfort. Under these conditions, and with bright hopes of cure without mutilation, patients are far more ready to consult their doctors with hope of relief, instead of hiding their tumours till it is too late for any form of radical treatment.

Against the use of radium, and in favour of surgical excision, must be placed the danger of leaving a portion of a cancerous growth non-irradiated, and of leaving infected lymphatic glands which might be removed by excision. The difficulty of arriving at the proper dose and exposure must also be reckoned. On the one hand the radiation may be too little ; on the other hand it may be too much, resulting in burning or sloughing of tissues and the formation of obstinate and slow-healing ulcers. Last, but not least, there is the danger to the health of workers in radium. Radium is a double-edged weapon, as the pioneers in this form of therapy have found to their cost. The housing, staffing, and maintenance of a radium institute for surgical purposes require very careful management and supervision, and are therefore costly.

The above seems to be a long array of arguments against the use of radium, but a little consideration will show that most of the points raised may be overcome by care and forethought.

Most of the results achieved in this country have been by means of super-ficial applications, by buried needles, by radon seeds, or by the combination of these three methods. Little has been done in the radiation of tumours from a distance by large quantities of radium—that is, 4 or more grm. at a time. This is known as distance radium therapy, or more commonly as the 'bomb' treatment, because a large quantity of radium is placed in a container —the 'bomb'—and applied in such a way that the radium rays may penetrate the affected area. We have not had sufficient radium to do much in this way, but it is a method which urgently requires investigation.

The summary of the argument is that a good case has been made out for the employment of radium. Hope for the cure of cancer is bright. A new weapon and a powerful weapon has been placed in the hands of the medical profession, though just how good it is impossible to say as yet. Nor is it yet possible to say whether patients with malignant disease should be treated with radium alone, or with radium combined with surgery or with X rays. One would think it probable that a judicious use of them all may be required ; but at any rate it seems clear that clinicians must be familiar with a use of all three methods.

What is required at the moment is work, intensive work, on the many problems which present themselves, combined with careful documentation of the methods used and registration of the results obtained. This calls for the co-operation of physicists, clinicians, radiologists, pathologists, and research workers. Some brilliant work has already been done, but much more requires to be accomplished before the story of radium can be told.

SHORT NOTES OF
RARE OR OBSCURE CASES

A CASE OF FIBROSARCOMA OF THE CERVICAL MENINGES.

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INTRADURAL tumours of the cervical meninges are comparatively rare, and although such cases are seen and operated upon successfully, very few have been reported in this country. The following case is of interest as immediate relief followed operation, although the symptoms were of two years' standing.

HISTORY.—L. P., age 28, was admitted to King's College Hospital in May, 1923, under the care of Dr. Aldren Turner, complaining of unsteady gait and pains in his shoulder. The onset of his complaint took place two years before admission to hospital, when the patient noticed pain in his right forearm. This was at times so severe as to prevent him from sleeping, and it gradually extended from the forearm to the shoulder. He stated that any sudden movement of his neck caused him severe pain, and to prevent this he kept his neck constantly bent downwards towards his chest.

About one year prior to admission to hospital he noticed weakness in his right leg. This was thought to be of a rheumatic nature, for which his doctor prescribed a liniment. However, the weakness became more marked, and the patient was unable to walk without the aid of a stick. When walking he could only drag the right leg along, and found it impossible to lift it from the ground. In January, 1923, he contracted influenza, and was in bed for eight weeks. He had lost two stone in weight since the commencement of his illness. When he was able to get about again in March, 1923, he found it very difficult to walk, even with the assistance of two sticks. He also complained of weakness in the right hand.

ON EXAMINATION.—When seen in May, 1923, he was found to be a fairly well nourished man. The right arm was considerably thinner than the left, although he was right-handed at his work as a joiner. There was a difference of two inches in the circumference of the upper arm on the two sides. There was very little difference in the measurements of the lower extremities, although the right leg was slightly smaller than the left. There were no motor disturbances on the left side of the body, while on the right side there was a well-marked atrophy of the muscles of the thenar and hypothenar eminences. The interossei appeared to be completely paralysed, as the patient could not separate his fingers at all. There was definite weakness of the flexors and extensors of the fingers. He could only stand with difficulty, and always fell

forwards and towards the right when his eyes were closed. Nothing abnormal was discovered in the chest or abdomen. The pulse-rate was 80, the respirations were 18, and the blood-pressure was 140 in the brachial artery.

There was no paralysis of any of the cranial nerves. The pupils reacted well both to accommodation and light. The right pupil was thought to be slightly smaller than the left ; the fundi appeared normal. The knee- and ankle-jerks were increased on both sides, ankle clonus was very marked on
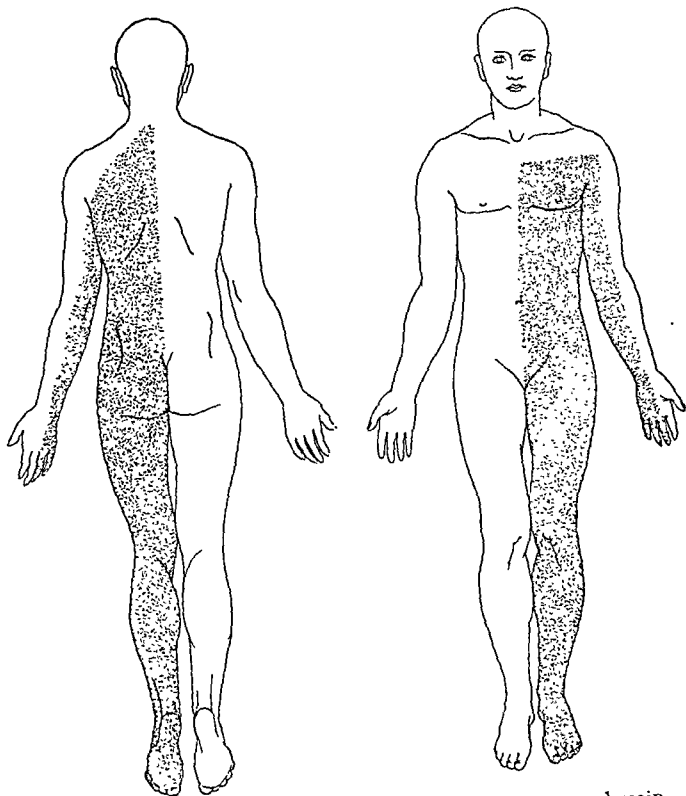
FIG. 177.—Showing areas of loss of perception to heat and pain.

the right side. The biceps- and triceps-jerks were increased in the right arm ; the abdominal reflexes were absent. With regard to sensory disturbance, there was no interference with the transmission of tactile impressions from either side of the body, but perception of heat and pain was lost over the whole of the left side from the level of the second intercostal space (*Fig.* 177).

There was no loss of muscle sense in the extremities.

Skiagrams of the cervical spine did not demonstrate any abnormality in the bones.

OPERATION.—Laminectomy was performed on May 10, under intratracheal ether anæsthesia. An incision was made as shown in *Fig.* 178, extending over the lower four cervical and upper two thoracic spinous processes. The spinous processes were bared of muscles and ligamentum nuchæ. The muscles were retracted by means of a self-retaining

FIG. 178.

laminectomy retractor. The spinous processes of the last cervical and upper two dorsal vertebræ were removed with bone-cutting forceps. The laminæ on each side were cut through with a laminectomy saw, and an intervening portion of bone was elevated by means of an osteotome and removed. There was very little extra-dural fatty tissue; the dura mater was seen to be distinctly tense, and there was a definite dilatation and tortuosity of the vessels on the posterior surface of the dura. A longitudinal incision was made into the dura just to one side of the mid-line, in order to avoid the largest longitudinal vessel on the surface of the dura. On opening the dura there was a sudden rush of cerebrospinal fluid, and an intradural tumour was seen lying on the right side of the cervical cord, causing definite compression. There were two nerve-roots in relation to the tumour,
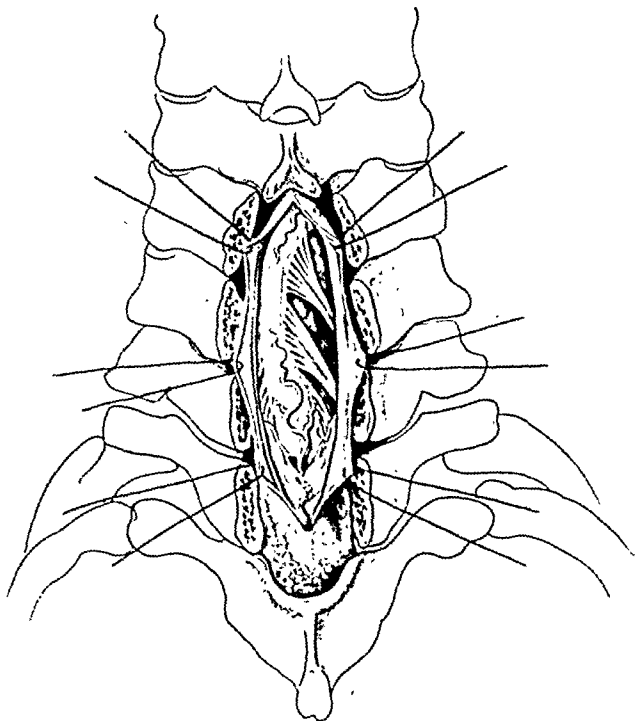
Fig. 179.—Diagrammatic drawing of tumour as seen after opening the dura mater.

acting more or less as anchors and keeping the tumour in position (*Fig.* 179). The two nerve-roots were carefully retracted, and the tumour bulged into the wound ; it could not be removed, however, as it was found to be attached to the dura mater opposite the 7th cervical vertebra. By means of a tenotomy knife the portion of dura mater adherent to the tumour was removed, together with the tumour (*Fig.* 180). There was not much loss of blood, and the blood-pressure was remarkably constant throughout the operation. At the commencement it was 160 ; it dropped to 100 when the dura was opened, but rose again so rapidly that when the patient left the operating theatre it was 150.

Fig. 180.—Appearance of tumour after removal. (× 2.)

The wound was irrigated gently with warm saline solution, and the dura mater was closed with interrupted catgut sutures. The spinal muscles were approximated with interrupted silkworm-gut sutures. A small drainage

tube was inserted down to the muscles, and the skin was closed with interrupted silkworm-gut sutures. Dressings were applied, but no support was used for the head. The patient was nursed lying flat on his back with his head between sand-bags for a week, after which time he was allowed to sit up. He was allowed to get up on the fifteenth day, and left hospital just three weeks after his operation. The wound healed *per primam intentionem*, the drainage tube having been removed after twenty-four hours.

The pathological report was as follows : " The tumour is a fibrosarcoma in which areas of hyaline degeneration can be seen."

AFTER-HISTORY.—Except for some shooting pains in the right arm there was no discomfort of any kind during convalescence. Motor power in the right leg gradually returned. Two days after the operation there was no field of anæsthesia to pain and temperature whatever.

The patient returned to hospital in October, 1928, to obtain a certificate for insuring his life, and I carefully examined him. There is practically no scar to be seen on the neck. There is equal muscular development and tone on both sides of the body, and no sensory loss in any part. It was really owing to seeing this patient again after five years, and finding him in such an excellent state of health, that I decided to publish the case.

COMMENT.

It is interesting to note that although operation was considered to be the right and proper treatment for tumours of the spinal cord by such men as Leyden, Erb, Byrom Bramwell, and Gowers, it was Horsley who first removed a tumour of the spinal cord on June 5, 1887. Since that date, which must be looked upon as the birthday of spinal-tumour surgery, many successful cases have been reported. Similar instances to the one here described have been reported by Sargent, Lennander, and Harvey Cushing.

The operative mortality of spinal-cord tumours is very low at the present day, while twenty years ago it was nearly 50 per cent. Harte, writing in 1905, stated that the operative mortality rate was 47 per cent, and De Martel, in 1910, recording his results in a series of 20 operations, had 9 deaths, a mortality rate of 45 per cent. From 1910 to the present time the operative mortality of tumours of the spinal cord has been getting smaller and smaller. In 1920 Sargent published a paper on his first 25 cases of spinal tumour ; his operative mortality was 20 per cent. He has kindly allowed me to quote his figures, which have just been brought up to date. In a total of 82 cases of tumours of the spinal cord there were 17 deaths. This mortality of 20·7 per cent includes all cases which died in hospital, some of which lived for a week or so after the operation.

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TWO CASES OF INTESTINAL OBSTRUCTION DUE TO STRANGULATION OF A LOOP OF SMALL INTESTINE IN AN OPENING OF THE LEFT BROAD LIGAMENT.

By ROBERT JANES,

DEPARTMENT OF SURGERY, UNIVERSITY OF TORONTO.

STRANGULATION of small intestine in an opening in the broad ligament seems to be very rare. A few cases of strangulation in pouches have been reported by C. H. Fagge[1] and B. H. Pidcock,[2] and one that I have been able to discover, through an opening in the ligament in the absence of a pouch, by H. A. Barr.[3] The number is so small that the addition of the following two case reports should be of value.

Case 1.—The first case was that of a married woman, age 58 years, who during the previous ten months had had repeated attacks of abdominal pain. These attacks had lasted from a few minutes to several hours, and had consisted of recurring severe cramps in the region of the navel. They occurred more frequently at night than in the daytime and were eased by walking about. On only one occasion had vomiting occurred. The last attack had begun twenty-four hours before admission to hospital, and had been much more severe than any experienced before; it had been accompanied by abdominal distension and repeated vomiting. There was symmetrical distension of the whole abdomen, which was slightly tender all over. A moderately tender, somewhat cystic mass was felt behind the uterus.

On entering the abdomen a coil of small intestine, 15 in. long, was found to have passed through a small opening in the left broad ligament. The bowel was distended, slightly œdematous, and tense. It entered the opening from in front and lay for the most part in the pouch of Douglas. The opening was a little less than 2 cm. in diameter and lay below the round ligament and Fallopian tube, immediately lateral to the uterine vessels. It was easily enlarged by the fingers, and the strangulated coil was then withdrawn. No sac was present. The margins of the opening were approximated with catgut and the abdomen was closed. Recovery was uneventful.

Case 2.—The second patient was a woman, age 36 years, the mother of seven children. Two or three months previously she had had an attack of abdominal pain which lasted one hour. Three days before operation she had developed severe crampy abdominal pain. In the first twelve hours this had remained severe in character and she had vomited two or three times. Since then there had been little or no pain, although the abdomen continued to feel sore. For a few hours before operation there had been some bloating and frequent vomiting. There was moderate general distension of the abdomen, which was tender in the left lower quadrant. The uterus was retroverted and freely movable, although movement caused some pain. There was tenderness in the left lateral fornix.

In spite of the presence of auricular fibrillation and a pulse-rate of 140 it was decided to open the abdomen. On exposing the intestine the ileum

FIG. 181.—*Case 2.* Showing the condition found at the operation.

was found to be obstructed at about 18 in. from the ileocæcal junction. The obstruction was in the region of the left side of the uterus. Slight traction dislodged the obstructed coil before it could be viewed in position. The bowel showed two rings of constriction which extended about four-fifths of the way around it. The obstruction had been of the Richter type. The wall of the bowel was viable.
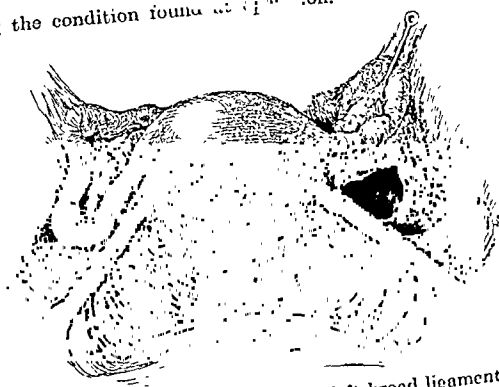
FIG. 182.—Showing opening of the left broad ligament.

The condition of the patient permitted no further exploration, and the operation was rapidly completed.

Death occurred from cardiac failure seventeen hours after operation. At autopsy an opening about 1½ cm. in diameter was found in the left broad
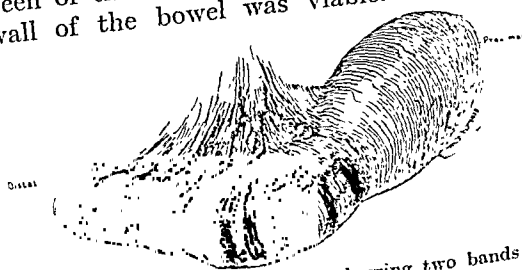
FIG. 183.—Strangulated bowel showing two bands of constriction.

ligament. The opening had a double margin which gave it somewhat the appearance of a double ring and accounted for the two bands of constriction on the obstructed bowel. The margins of the opening were quite thin. There was no pouch. The intestine was still in good condition, and the obstructed portion along with the pelvic structures was removed for preservation. I am indebted to Miss M. T. Wishart for the accompanying pen-and-ink drawings which were prepared by her from these specimens (*Figs.* 181–183).

I am aware of no embryological explanation for the occurrence of openings in the broad ligament. Both of these patients were parous, and it is conceivable that the openings were in some way related to pregnancy. The margins of the openings were thin and did not suggest previous inflammatory change, nor were there other evidences of pelvic inflammation.

The diagnosis of this lesion is not likely to be made before the abdomen is opened. The presence of a soft tender mass in the pouch of Douglas, such as was felt in the first case, or of definite tenderness on moving the uterus and in the fornix or pouch of Douglas as in the second case, in the presence of an obvious intestinal obstruction, might suggest the diagnosis.

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TRAUMATIC RUPTURE OF THE SPLEEN INVOLVING THE PEDICLE: SPLENECTOMY: COMPLETE RECOVERY.

A RARE RUGBY FOOTBALL INJURY.

By GEORGE ARMITAGE,

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THE case to be described is one of traumatic rupture of the spleen involving the pedicle, which was almost completely severed—the result of a severe injury to the abdomen sustained whilst playing Rugby football. Three points, very typical of rupture of a healthy spleen in general, are strongly emphasized—namely, the left-sided shoulder pain or omalgia (Kehr's sign), a well-marked lucid interval of at least five and a half hours, and the delayed or reactionary nature of the hæmorrhage. The latter is particularly striking in view of the fact that the pedicle was almost completely severed, the condition being well illustrated in the accompanying drawings by Miss Wright (*Figs.* 184. 185).

T. W., age 19, was playing football on Oct. 15, 1927. At about 3.30 p.m. he sustained a severe injury to the abdomen in attempting to stem a forward rush. He collapsed much in the same way as does a man who is severely

winded, in fact this was thought to be the trouble, and for this he received the customary first-aid attention. After resting two or three minutes he made an attempt to continue playing, but found this impossible. He was assisted from the field to the dressing-room, where he felt faint, but with assistance he changed, was given brandy, and felt considerably better. In fact, except for a very severe pain in the left shoulder, rendering him quite unable to move the arm, he felt more or less himself. The shoulder was examined by the ambulance man in attendance, who could find nothing to explain the severe pain, but quite properly advised him to have an X-ray
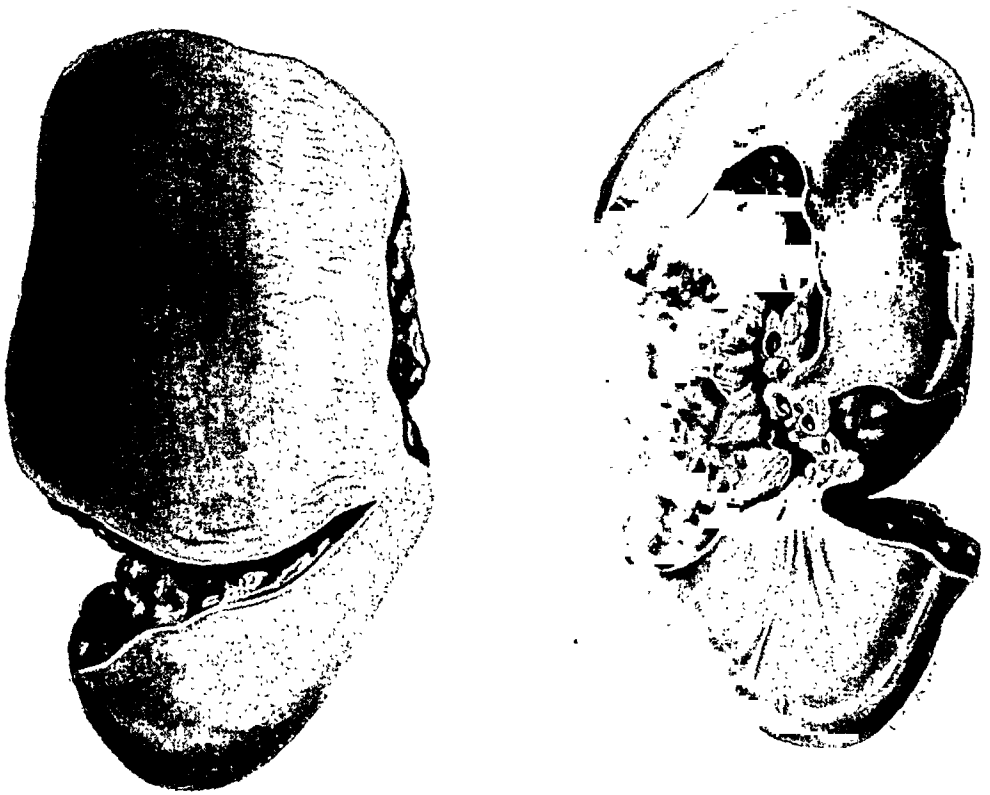
FIGS. 184, 185.—Traumatic rupture of the spleen.

photograph taken at the earliest possible moment. With the arm in a sling, the patient motored home, a distance of fifteen miles, as a passenger in an open side-car. At 6 p.m. he felt well enough to visit friends two miles away, travelling in an electric tramcar. At 9 p.m., however, he commenced to feel 'groggy'—this feeling coming on, he states quite emphatically, with extreme suddenness, and he decided to return home, his friends, being struck by his sudden pallor, motoring him back. His condition—acute pain in the left shoulder now even more severe than before, together with shortness of breath, feeling of coldness, increasing pallor, associated with a very rapid thready pulse, and restlessness—compelled him to seek further advice, and he was

brought to hospital at 11 p.m., obviously suffering from internal hæmorrhage, and a probable diagnosis of ruptured spleen was made.

After a period of intensive anti-shock treatment in bed lasting about three-quarters of an hour, his condition was improved, he was warmer in some degree at any rate, though still cold and clammy, his pulse was perceptible at the wrist, and it was decided to perform a laparotomy under gas and oxygen anæsthesia, combined with morphia previously administered. The peritoneal cavity was full of blood, evidently of very recent origin. The spleen was practically free, and, upon being manipulated, most alarming hæmorrhage occurred, obviously from the torn pedicle. A clip was hurriedly placed in the remaining portion of the pedicle attached to the spleen, which was removed. By gentle traction upon the stomach the splenic pedicle was brought forward, and with extreme difficulty the hæmorrhage was controlled and the abdomen closed. The patient was now only just alive, as can well be imagined ; there was no pulse at the wrist, very shallow gasping respirations being the only visible sign of life. Intravenous saline—two pints—was given in the operating theatre, and he was removed to the ward, where intravenous saline was continued in the drip fashion, radiant heat being administered as well as the customary anti-shock medicinal treatment. In twelve hours' time his condition was improved, and he proceeded towards recovery with an absolutely uninterrupted convalescence.

He was discharged from hospital on Nov. 19, 1927. On this date his blood-count was as follows : Leucocytes, 10,200 per c.mm. ; hæmoglobin, 88 per cent ; red cells, 5,320,000 per c.mm. ; colour index, 0·83. Film report : the red cells and leucocytes appear normal except that of the latter the number of degenerative forms is noteworthy. Differential leucocyte count : normal.

Seen fifteen months after operation, the patient is perfectly well, in strict training, desirous of taking part in football again, but at present being prevailed upon by wise parental influence to refrain.

In *Fig.* 185 it will be seen that a small portion of the tail of the pancreas is visible, indicating that the ligatures around the pedicle must have included some of this organ without any apparent ill effect.

There is little doubt that a lucid interval occurs invariably in the symptomatology of rupture of a healthy spleen. That this is due to a complete cessation of hæmorrhage after a sudden initial one is not easy to understand, neither is it probable. The sudden onset of shock, which was preceded by an interval of five and a half hours during which time the patient was apparently normal except for severe pain in the left shoulder, suggests that following the injury there was a retraction of the muscle coats of the severed arterial vessels preventing gross hæmorrhage either from the torn pedicle or from the ruptured spleen itself, whose blood-supply had been very materially lessened. During the lucid interval there occurred a slow leakage of blood both from the pedicle and from the spleen in spite of the contraction of its capsule, which continued until the volume of blood lost from the circulation was sufficient to cause the onset of sudden shock.

PRIMARY JEJUNAL ULCER.

By J. M. BLACK, DUNFERMLINE.

THE rarity of primary ulceration of the jejunum prompts me to record the following case.

D. H., a miner, age 53 years, was admitted to the Dunfermline and West Fife Hospital on Feb. 10, 1928, about 8 p.m.

HISTORY.—At 4 a.m. on Feb. 10 he was awakened with sudden very acute pain in the epigastrium, and vomited some mucus. The pain became localized to the right iliac region, and although the bowels operated there was no abatement of pain. He had no more vomiting, no shoulder-tip pain, and no symptoms affecting micturition. His doctor was called in and sent him to hospital, with a diagnosis of acute appendicitis. He has had no indigestion or previous trouble with his stomach or bowel, although on closely questioning him after operation he admitted having had a little flatulence lately.

ON EXAMINATION.—The man looked ill, his face was grey and drawn, and he was moaning with pain. The temperature was 99° and the pulse 68 per minute. The abdomen was retracted and movement of the abdominal muscles was very limited. Rigidity and tenderness were generalized. There was no loss of liver dullness. The diagnosis was : perforated gastric ulcer, or ruptured appendix.

OPERATION.—Operation was performed at 8.30 p.m.—sixteen hours after the onset of his symptoms. The abdomen was opened through the right rectal sheath. The parietal peritoneum was congested, and on opening it there was a rush of green watery fluid. The cæcum which was delivered was large, and a normal appendix was removed. The incision was extended upwards, and the gall-bladder although distended was normal. The stomach and duodenum were congested, but no perforation or ulcer was present, and no lymph was observed in this region. The transverse colon was delivered and the left hypochondrium investigated. In this region there was a large amount of green lymph. The jejunum was traced from the flexure. At a point about two feet from its commencement, and on the antimesenteric border, a congested area about the size of a sixpence with a yellow slough or plug of lymph in its centre was seen. The plug was sponged off, and intestinal contents—green watery fluid—appeared through the perforation, which was the size of a match head. The portion of the jejunum bearing the ulcer was excised and a lateral anastomosis performed. A suprapubic glass drain was inserted and the abdomen was closed ; 80 c.c. of B. welchii antitoxin were administered intramuscularly.

The patient made a good recovery although his wound was infected. and he was discharged feeling very fit on March 14, 1928.

The resected portion of the intestine was examined by Dr. Harvey, of the Royal College of Physician's Laboratory, Edinburgh, who reported as follows : " Macroscopically there is evident a small ulcer of the mucous membrane, and a section through this shows continuity with a minute

perforation on the serous surface. Microscopically there is an acute inflammatory-cell (pus) reaction, with exudation extending from the Lieberkühn's glands of the mucous membrane to the peritoneum. On the peritoneal surface there is a fibrinous necrotic exudate indicating the position of the perforation." (*Fig.* 186.)

Ulceration of the jejunum following gastro-enterostomy is an occurrence which appears only too frequently. Hurst states that it occurs in from 5 to 10 per cent of cases of gastrojejunostomy. On the contrary, ulcer of the jejunum unassociated with gastro-enterostomy, or what is termed primary
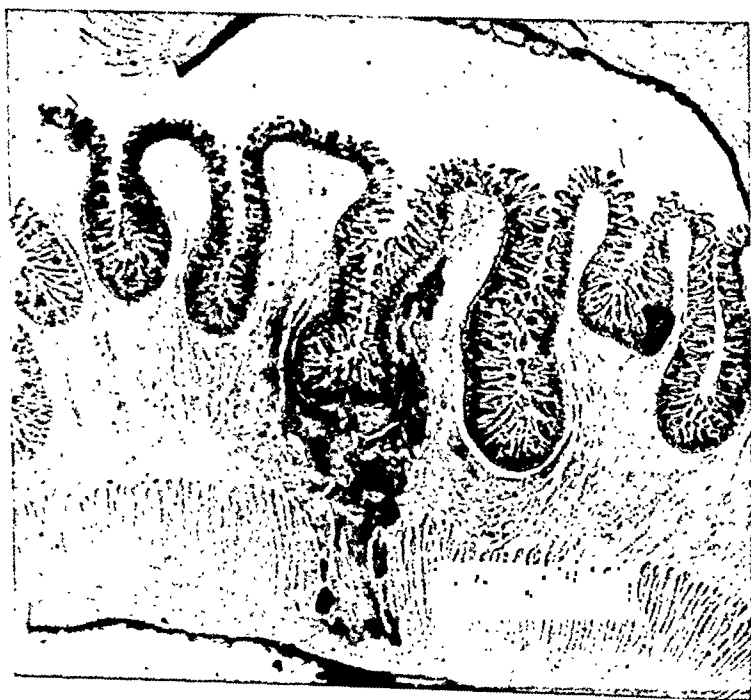
FIG. 186.—Section from the resected segment showing area of ulceration.

or simple ulcer of the jejunum, appears to be an extremely rare lesion. The subject was discussed by Adams[1] in the BRITISH JOURNAL OF SURGERY in 1926, and Richardson[2] in 1922 analysed 12 cases of primary jejunal ulcer, in 10 of which perforation occurred, and in 7 of these the ulcer was chronic. Even in 1924 Paterson Brown[3] was able to collect only 35 cases of primary ulcer of the jejunum and ileum.

In the present case the ulcer was acute, and from the fact that there was no coincident gastric or duodenal ulcer, and that syphilis (Wassermann negative), typhoid, and simple distension could be excluded as causes, we may assume that the lesion was an acute primary jejunal ulcer.

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DOUBLE INTUSSUSCEPTION OF THE JEJUNUM ASSOCIATED WITH A POLYPUS.

By W. C. SOMERVILLE-LARGE,

SURGICAL REGISTRAR AT THE ADELAIDE HOSPITAL, DUBLIN, AND
ASSISTANT SURGEON TO THE MEATH HOSPITAL, DUBLIN.

THE patient, a boy, age 17, was admitted as an abdominal emergency to the Meath Hospital and County Dublin Infirmary on Saturday, Dec. 22, 1928, at 11.45 p.m.

HISTORY.—The patient's past history and family history were of no clinical importance. At 5 a.m. on the day of admission he woke up with an acute pain across the upper part of his abdomen. This was very severe and he kicked about in an effort to get relief. It was colicky in type and remained localized to the upper and central parts of his abdomen. The pain continued very severe till the late afternoon, when it eased considerably, but at no time was he free from pain the whole day.

Vomiting.—Up to the time of admission he had vomited, in all, three times. The first time was at 10 a.m. immediately following the administration of a cup of Bovril. The other times occurred in the afternoon following drinks of water. The quantity vomited was the amount drunk. There was no hæmatemesis, and the vomiting slightly relieved the pain.

Bowels.—No motion of the bowels had occurred on the two days previous to the attack. On the day of the attack at 6 a.m. he was given approximately 1 oz. of castor oil, and as this had no effect, at 8 a.m. he took ½ oz. more. He retained the oil until 10 a.m., when he took the Bovril, and the oil was vomited with the Bovril.

Three enemas were administered on the day of the attack, the first at about 10.30 a.m. after the oil was vomited ; this returned coloured fluid and one small lump. The other two enemas were given, one in the afternoon and the other in the evening after admission, and they returned just coloured fluid. No abnormal colouring was noted in any enema.

ON EXAMINATION.—The temperature was 96·5° and the pulse 100. The patient was a well-nourished boy of slight build. The face was flushed and the tongue coated and moist. The abdomen was not distended, and moved easily with respiration. Palpation revealed a tumour situated above and to the left of the umbilicus. It felt the size of a clenched fist, was soft in consistency, smooth on the surface, and movable apart from the anterior and posterior abdominal walls. The tumour was tender on pressure and dull on percussion and did not move with respiration. A rectal examination revealed nothing abnormal. The case was regarded as being one of intestinal obstruction ; immediate operation was advised, and performed some twenty hours after the beginning of the symptoms.

OPERATION.—At operation a left rectus incision was made above the umbilicus, and intra-abdominal palpation confirmed the presence of a large tumour which necessitated lengthening the incision below the umbilicus in order to deliver the tumour outside the abdomen. On visual examination

the tumour appeared to consist of two intussusceptions of the jejunum situated close together, the distal one being very much the larger. Incomplete reduction of the smaller one was effected, but no reduction whatsoever could be effected in the larger one. The gut above the intussusceptions was partially distended, and that below partially collapsed. The mesentery was very thick and contained numerous enlarged lymph glands. The segment of gut containing the intussusceptions was excised and continuity restored by an end-to-end anastomosis.

The boy was discharged from hospital on Jan. 27, 1929. His convalescence was uneventful and he had gained $1\frac{1}{2}$ lb. in weight since the operation.

PATHOLOGICAL REPORT.—The length of intestine removed, as measured after lying three weeks

FIG. 187.—Double intussusception. A, Proximal end of gut; B, Distal end of gut; C, Proximal intussusception groove; D, Starting-point of distal intussusception; E, Groove corresponding to apex of distal intussusception.

in formalin, was 150 cm. From the outside the specimen appeared to be two intussusceptions of the jejunum, the distal one being very much the larger (*Fig.* 187). The mesentery was very much thickened and contained numerous enlarged lymphatic glands which showed on section evidences of an acute hæmorrhagic inflammation.

On making a longitudinal
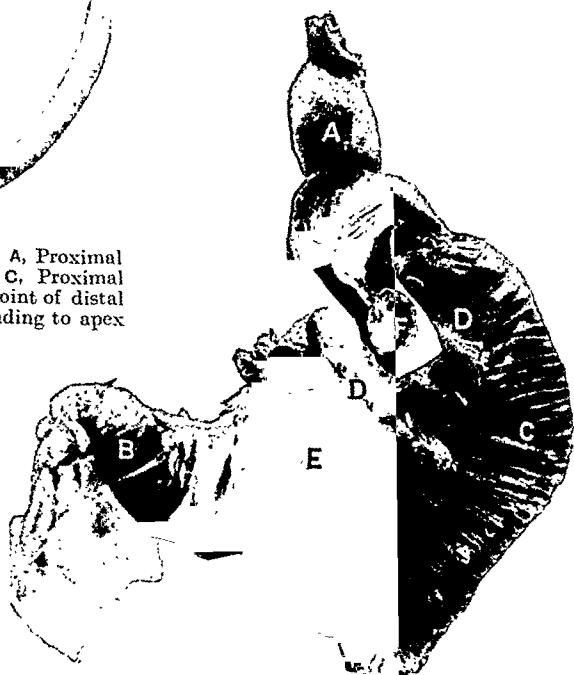
FIG. 188.—The entering layer of the distal intussusception has been opened completely, disclosing apex of proximal intussusceptum with polypus attached. The line of constriction can be seen just above the polypus. A, Proximal intussusception groove; B, Distal end; C, Ensheathing layer of distal intussusception; D, Returning layer of same; E, Entering layer of same, which is opened in its proximal part to disclose F, Polypus.

incision through the ensheathing layer of the distal intussusception about half a pint of blood-stained fluid escaped, and the intussusceptum which was revealed showed a well-marked gangrenous line. The length of this intussusceptum was 35 cm., and the distance from the apex of the intussusceptum to the gangrenous line was 19 cm. When the returning layer of the intussusceptum was opened by a similar incision more blood-stained fluid escaped. This fluid held the serous coats of the entering and returning layers apart, and between these two coats there were no adhesions. The mucous membrane on the concave side of the intussusceptum had been obliterated by pressure, as also had that on the opposing side of the receiving layer. The entering intestine was kinked with the mesentery and very tightly gripped where it entered the gut below.

On opening the ensheathing layer of the smaller and proximal intussusception it was found that the apex of the intussusceptum could not be reached, as it was firmly gripped in the same constriction that held the intussusceptum of the distal intussusception. When this constriction was divided and the entering layer of the distal intussusception incised, a swelling the size of a walnut was found beyond the constriction at the end of the proximal intussusceptum. This is clearly shown in *Fig.* 188. This swelling proved on section to be a polypus. The length of the proximal intussusceptum was 12·5 cm.

I am deeply indebted to Professor Boxwell for his assistance in preparing the pathological report, and to Dr. F. S. Bourke for his excellent drawings.

Comments.—Fitzwilliams, writing on the classification and varieties of intussusceptions based on the study of 1000 cases, says : " Double intussusceptions are those in which the sheath has become folded upon itself, and this form presupposes a loose sheath. Double intussusceptions are almost invariably found starting in the lower end of the ileum or at the ileocæcal valve, as the colon in these varieties loosely envelops the small intestine." Double intussusceptions in other parts of the alimentary tract are very uncommon.

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¹ACUTE PANCREATIC NECROSIS IN ASSOCIATION WITH DIVERTICULA OF THE INTESTINE.

BY H. W. L. MOLESWORTH,

ASSISTANT SURGEON TO THE ROYAL VICTORIA HOSPITAL, FOLKESTONE.

THE following case of pancreatic necrosis is of interest because of the possible causal relationship of diverticula of the intestine.

G. A., a male, age 45, was admitted to hospital on Sept. 8, 1928. During the last two years he had experienced two attacks of severe abdominal pain which lasted a few hours and ended with complete recovery. At 4 a.m. on the day of admission he was awakened by severe abdominal pain ; this increased until 7 a.m., when he sent for a doctor. There was no vomiting ; his bowels had acted ; no flatus was passed.

When seen at 11 p.m. the temperature was 101° and the pulse-rate 116. The patient was somewhat stout, but otherwise presented a normal appearance. The abdomen was somewhat distended, markedly rigid, and there were

no palpable swellings. Rectal examination was negative ; liver dullness could not be made out. The facies was distinctly 'abdominal', and he had a dry furred tongue. The clinical diagnosis was uncertain ; we considered it likely that this was a case of diffuse peritonitis probably due to a perforated diverticulum.

OPERATION.—The abdomen was opened under spinal anæsthesia at 11.30 p.m. There was much orange-coloured glairy fluid, but no gas. The appendix was normal, and there was no perforation of stomach or duodenum. At the junction of the first and second parts of the duodenum, two minute white specks were observed at the pancreatic margin of the gut. On inspection of the rest of the abdomen, the sigmoid was thickened, and several diverticula filled with hard fæces were observed. A marked swelling of the retroperitoneal tissues to the outer side of the sigmoid was incised, with exudation of much foul-smelling serous fluid ; following this upwards the tail of the pancreas was found to be necrotic.

On opening the gastrocolic omentum, two small fat necroses were seen. The body of the pancreas was but slightly indurated. Drainage was established : (1) Through the gastrocolic omentum ; (2) Through a stab wound in the loin to the tail of the pancreas ; (3) To the outer side of the sigmoid. At the close of the operation the patient, who had exhibited no previous signs of disturbance, became severely shocked, and died about an hour later.

POST-MORTEM.—At a limited post-mortem performed twelve hours after death, the gall-bladder, bile-ducts, duodenum, transverse colon, and pancreas were removed *en bloc* and dissected. The necrosis of the pancreas was confined to the tail ; a careful search failed to show other evidence than was found at operation. The gall-bladder was adherent to the transverse colon, and contained three small, soft bilirubin-calcium stones ; the bile was golden yellow and clear. The wall of the gall-bladder was apparently normal, and the gland at the cystic duct not enlarged. The common duct was not enlarged and contained no stones. The ampulla of Vater appeared to open on the summit of a diverticulum of the duodenum, large enough to admit the tip of a finger. The opening of the duct of Wirsung and of the bile-duct was a common one ; the duct of Santorini was not found. Three-quarters of an inch below the opening of the common duct, a second, slightly larger diverticulum, about 2 cm. in diameter, burrowed into the substance of the pancreas for about this distance. This did not appear to be associated with the opening of any duct, but post-mortem digestion made it difficult to carry out a dissection as accurately as was desired. The body of the pancreas was somewhat indurated, and the terminal one and a half inches of the organ were the seat of hæmorrhage and necrosis. The retroperitoneal tissues were necrotic and swollen with sloughs and foul-smelling fluid which infiltrated the whole of the left side of the posterior abdominal wall.

Comment.—In this case it is possible that the usual explanation of biliary infection, as evidenced by the finding of three calculi, may have been sufficient to activate the pancreatic enzymes, and that the association of duodenal and colonic diverticula was purely accidental. It is, at least, equally possible that infection from a thin-walled duodenal diverticulum was the causal factor in the train of events leading to the loss of this patient's life.

ILEO-COLOSTOMY:

A REPORT OF AN ACCIDENT FROM THIS OPERATION, WITH SOME REMARKS UPON THE RESULTS OF A CLOSED ILEAL LOOP IN MAN.

By H. W. L. MOLESWORTH,

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ANASTOMOSIS between the small intestine and the transverse colon may be called for under the following circumstances: (1) As part of the operation of excision of the right half of the colon (Friedrich's operation); (2) As a palliative operation in the exclusion of the right half of the colon for malignant disease, for tuberculosis, actinomycosis, or other inflammatory disease of the cæcum or ascending colon; (3) In intestinal obstruction where for any reason a more direct attack on the cause of the obstruction is not considered advisable; (4) In peritonitis, as advocated by Sampson Handley. The simplest and speediest form of this operation is a lateral anastomosis between small intestine and the transverse colon, and in this form the operation must have been performed many hundreds of times.

The following case is reported because it illustrates a complication which is uncommon; and also because it has reproduced in the human subject an experiment bearing on the vexed question of toxæmia in intestinal obstruction.

L. B., male, age 14, was referred to me by Dr. W. W. Nuttall as a case of intestinal obstruction.

HISTORY.—The patient had been operated on for acute appendicitis at the age of 5, and at this time drainage had been instituted. He had never been robust, and had suffered from many 'bilious attacks'. In the attack for which he was admitted to hospital he had complained of abdominal pain and vomiting. Bowels had acted in an unsatisfactory manner.

ON ADMISSION.—Temperature was 99°; pulse 110; he had a dry tongue and an abdominal facies. Coils of small intestine could be seen and felt. Enemata brought away a little fæces, and some flatus was passed, but his distension and his pain were not sensibly relieved.

FIRST OPERATION, June, 1927.—The abdomen was opened under spinal anæsthesia with novocain. The small intestine was very distended, being about two inches in diameter, the gut was congested, and much free fluid was present in the peritoneal cavity. Obstruction was caused by a very dense mass of adhesions in the right iliac fossa. The intestine was so thin that dissection of these adhesions would have proved lengthy and hazardous, and an anastomosis between a distended coil and the transverse colon was commenced. So thin was the gut that each stitch leaked. The anastomosis was isolated with omentum and a high jejunostomy performed. From this severe operation, aided by vigorous treatment with subcutaneous saline, the patient made a surprisingly smooth recovery. For the next year his condition improved greatly. He attended school and played active games; but he had at least a dozen attacks of pain of a spasmodic character. I was asked to see him on at least three occasions, but could never find any definite physical signs.

In August, 1928, a year after his discharge from hospital, he was re-admitted with a rather more severe attack accompanied by vomiting. He did not appear to be ill, bowels acted regularly, and he rapidly recovered. A barium meal and enema at this time revealed no abnormality. During the attack slight evidence of distended intestine was apparent in the shape of palpable coils; after the attack, though there was still some slight distension, individual coils were no longer appreciable. In spite of these findings he was plump and looked the picture of health.

In March, 1929, he was re-admitted complaining of severe pain and vomiting. He had attacks of pain every few hours, at the height of which he would vomit. Temperature was 99°, pulse 84, with a clean moist tongue. Between the attacks of pain he looked perfectly well and felt perfectly well. Bowels acted regularly without enemata. There was slight distension, with coils of visible and palpable intestine. Temperature rose to 100·6°, pulse-rate between 80 and 88. There was not the slightest resemblance to the abdominal or toxæmic facies.

SECOND OPERATION.—Access was gained by excising the old scar. A marked excess of slightly blood-stained fluid escaped on opening the peritoneum. A very distended coil of small intestine was found. This was at
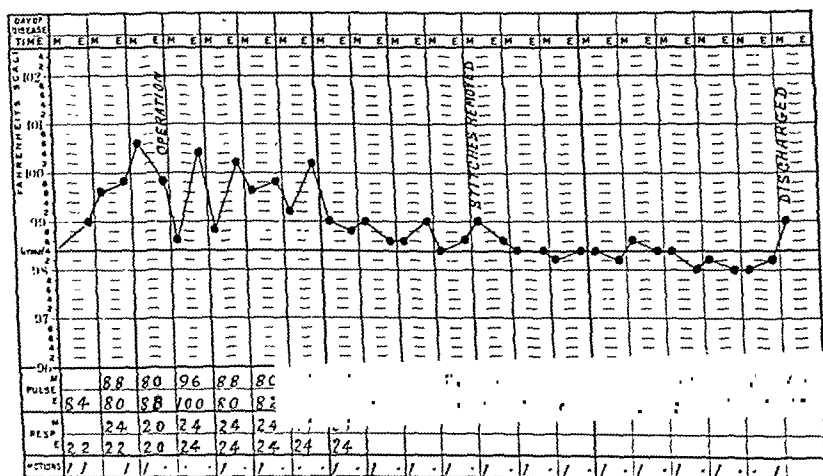
FIG. 189.—Chart at time of second operation.

least as distended as at the previous operation, with a strong tendency for its peritoneal coat to split. It proved to be a length of about four feet of intestine distal to the ileocolostomy. It had passed from the left of the anastomosis through the ring bounded in front by the anastomosis, above by the transverse mesocolon, behind by the posterior abdominal wall, and below by the mesentery of the small intestine. Having passed through this ring it had rotated in an anti-clockwise direction through rather more than a complete turn. Neither the hernia nor the volvulus were of recent occurrence, as was demonstrated by their being fixed by somewhat dense adhesions. The content of the loop was a thin yellow offensive fluid. There was no gas. Having emptied the loop it was apparent that reduction of this hernia and

volvulus was impossible, so that a second anastomosis between the closed loop and the sigmoid was made. Recovery was uneventful. (*Fig. 189.*)

Comment.—Apart from the interest of this case as a curiosity, the reproduction of the closed ileal loop experiment in man throws a little light on the problem of toxæmia in conditions of ileus. The case demonstrates the following points : (1) A closed ileal loop which is congested can exist for at least three days without demonstrable toxæmia. The only evidence of toxæmia was a moderate pyrexia, which is not characteristic of the toxæmia of obstruction. (2) A previous obstruction in continuity in the same patient produced marked toxæmia. (3) It is probably a fact that some distension of the same loop had existed for nearly a year without damage to his general health.

Without going into the vast amount of clinical and experimental research which has been published in the last fifteen years, this case and others like it, both in man and animals, offer obstacles to the acceptance of a recent theory which appears to have received a too ready assent. The anaerobic toxæmia theory formulated by Williams[1] may, I think, be not unfairly summarized as follows : The enormous increase in the numbers of *B. welchii* in the obstructed intestine, coupled with the resemblances between a man dying of obstruction, of peritonitis, and of gas gangrene, suggests a common cause. Experiments designed to establish the existence of a toxin lethal to mice showed that in 28 out of 54 experiments a fatal result was achieved, while the protected mice all recovered ; a series of cases treated by anti-gas-gangrene serum show a low mortality. While the last statement is certainly true, the series is too small and too inadequately controlled to be entirely conclusive.

In Williams's paper the statement is found : " The lower part of the small intestine thus appears to be the only part of the bowel suitable for proliferation of *B. welchii* and formation of toxin." If then the organism, which he debits with a large proportion of the mortality in obstruction and in peritonitis, is most frequent in the ileum, we should expect that closed ileal loops would exhibit anaerobic toxæmia at its worst. The experimental and clinical facts which are against this are too numerous to be gainsaid. It is surely unwise to accept enthusiastic clinical reports of a serum treatment so quickly as the reports of benefit from anti-gas-gangrene serum have been accepted in this country. Williams, in remarking on the difficulty of obtaining intestinal material, states that " jejunostomy and ileostomy are not frequently performed on these cases at St. Thomas's Hospital ". Is it not possible that parallel series of cases treated by jejunostomy where indicated and by vigorous administration of sodium chloride solutions, as has been advocated abroad for years, and recently re-advocated by Haden and Orr, would show equally striking results ? Such has been the present writer's experience.

Though all surgeons advocate the administration of saline in toxic cases, it is worthy of remark that the proportion of patients who actually receive saline into their circulation is a small one, and depends in no slight degree on the energy of house surgeons and nurses. Too often saline is not given until the pulse begins to fail. It is then given rectally and, usually, too rapidly to be retained.

REFERENCE.

[1] WILLIAMS, B. W., *Brit. Jour. Surg.*, 1926, Oct., 295.

REVIEWS AND NOTICES OF BOOKS.

Praktische Differentialdiagnostik für Ärzte und Studierende. Chirurgie. By Professor Brüning (Giessen), Dr. Honigmann (Breslau), and Dr. Kayser (Dillenburg). Volume IV. Medium 8vo. Pp. 408, illustrated. 1928. Dresden and Leipzig: Theodor Steinkopff. Paper covers, M. 25.50; bound, M. 28.

This is the surgical section of a large systematic work on diagnosis, intended for use and reference by students and practitioners. It is a very simple and clearly written account of all the common surgical diseases and accidents, dealing only with symptoms and diagnosis. It is divided into five parts. The first describes general infections, and is followed by sections on the regional affections of the head, neck, and chest; the abdomen, back, and limbs; and the bladder, ureters, and kidneys. Some care is expended on describing methods of examination, and there is a judicious selection of subjects of the greatest importance for discussion. The book is full of accurate information, compressed into a very small compass. It suffers chiefly from the absence of tabular arrangement, diagrams, or any of the lighter methods of making difficult things seem easy.

It is not clear why the fourteen plates which are given at the end of the book should all be required for the section on the urinary organs, whilst the four other sections remain unillustrated.

Annals of Roentgenology. Vol. VIII. The Vertebræ, Roentgenologically Considered, including a Study of Industrial Accident Cases. By Arial Wellington George, M.D., Sc.D., F.A.C.R., Sir James Mackenzie Davidson Memorial Lecturer, 1923, etc.; and Ralph Davis Leonard, A.B., M.D. Imperial 8vo. Pp. 256 + xxv, with 203 Roentgen-ray studies, 13 clinical illustrations, and 1 coloured plate. 1929. New York: Paul B. Hoeber, Inc. $10.00 net.

Under the editorship of Dr. Case and under the title *Annals of Roentgenology*, a series of radiological monographs have been published of which this is the eighth. It is therefore obviously a book of reference on diseases and injuries of the vertebræ, though it is written mainly from the point of view of industrial accidents.

The skiagrams are reproduced in negative, which is really of no advantage. Study of the transparent negative is of more value than the study of a positive print, but the study of a good positive transparency gives all the information of the negative : on the other hand a negative print has even more disadvantages than the positive print. A Rather Irritating Feature To The British Reader Is That All Descriptions Of Illustrations Are Printed Like This. It takes the attention off the subject matter. The general get-up of the book is superb ; print, paper, and reproductions being beyond reproach. No one will quarrel with the authors for making the work mainly a record of their own practical experience, for this is wide enough to provide an excellent book of reference.

After a general description of the various diseases and injuries of the vertebræ, each portion of the vertebral column is considered separately. In the general part, typical illustrations are given of most of the injuries and diseases of vertebræ. In the sectional part, the normal structure of the vertebræ is studied by skiagrams of dry bones, often compared with photographs of these same vertebræ, and then various abnormalities, injuries, and diseases are studied. The authors have rather heterodox views as to some of the changes occurring in vertebræ, notably the

formation of osteophytes on the vertebral bodies. They bring to the fore an important fact, namely, the frequency of destruction of the intervertebral disc in tuberculosis, and its importance in the differential diagnosis from fracture. They draw attention to the important fact that no new bone is thrown down in the healing of vertebral tuberculosis unless there is a secondary infection. Kümmel's deformity is very carefully discussed without the authors expressing very decidedly their own views.

On the whole, the difficult and thorny questions in this subject are dealt with in a very efficient and sensible manner. The book concludes with quite a good chapter on medico-legal expert testimony. Obviously American law in accident cases is very similar to our own. The work is thoroughly to be recommended not only to every radiologist, but to all medical men interested in industrial accidents.

The History of Hemostasis. By SAMUEL CLARK HARVEY, M.D., Professor of Surgery, Yale Uni· · ·· S·· ·· ·· ·- ᶜʰⁱᵉᶠ New Haven Hospital. Crown 8vo. Pp. 128 + xv, with 19 ·   : ''.   I lon: Humphrey Milford. 7s. 6d. net.

IT is difficult to know for whom this book has been written. It is too abstruse for general reading ; it is not useful to the surgeon, and it does not appeal to the medical historian. The initial mistake appears to be that the writer began his little essay on so large a scale that he has assigned too much space to the classical period during which there was little more than mere repetition of old and discarded methods. This has left him insufficient room to tell of the more recent methods of arresting bleeding, about which the average surgeon would like to be informed. There is no account, for instance, of the use of living muscle for this purpose, or of the ingenious ways of keeping wounds dry by suction methods. The medical historian, too, is pained and surprised when he reads that Clowes, the most outspoken of Elizabethan English surgeons, 'wrote in French'. The date (1596) attached to his name means nothing, for he was born about 1540 and died in 1604. There is also a mistake about Gale's method of arresting hæmorrhage. He does not expressly mention ligature, but states that he passed a stitch round the wounded artery or vein when it was a large vessel, and presumably when he had done this, he tied off the thread. The book is well produced as regards paper, type, and illustrations. There is an index of personal names as well as a subject index. The pages devoted to the index of personal names might, with advantage, have been used for a short bibliography.

The Physics of X-ray Therapy. By W. V. MAYNEFORD, M.Sc., Physicist to the Radio-therapeutic Department of the Cancer Hospital (Free), London. Post 8vo. Pp. 177 + viii, with 106 illustrations. 1929. London: J. & A. Churchill. 10s. 6d. net.

To the average medical man, the acquisition of a knowledge of physics appears to present many difficulties, yet in these days when so much radiotherapy is employed, a good understanding of the physics of the subject is essential. This book, which was written at the suggestion of the late Dr. Robert Knox, is most welcome, since it presents the subject in a very readable manner, and will be readily understood. even by those with only a slight knowledge of the subject ; yet none of the essentials are omitted. There are 171 pages of text divided into seven chapters, the last dealing with the latest types of X-ray apparatus and tubes. Secondary scattered X rays, the quality of scattered rays, and X-ray absorption are dealt with in Chapters 3 and 4, while in Chapter 5, X-ray measurements are very fully dealt with, and are followed in the next by a most interesting résumé of important factors affecting choice of therapeutic conditions. The book can be strongly recommended to radiologists and to those studying for the D.M.R.E. diplomas, as it gives all the information necessary without entering into all the somewhat intricate details of a purely physical text-book.

Problems in Surgery: University of Washington Graduate Medical Lectures, 1927. By GEORGE W. CRILE, M.D. Edited by AMY F. ROWLAND. Medium 8vo. Pp. 171, illustrated. 1928. Philadelphia and London: W. B. Saunders Co. 18s. net.

THIS volume consists of a series of lectures delivered at a graduate course at the University of Washington. It does not claim to be exhaustive in regard to any of the subjects dealt with, but it reflects very clearly the author's views in regard to subjects of commanding interest in present-day surgery. Of the six lectures included in the book those on " The Management of the Acute Infections ", " Operations on the Bad-risk Patient ", and " The Mechanism of Hyperthyroidism " are of special interest and give very clear and readable digests of the author's well-known views on these subjects. The informal manner in which the various questions raised are dealt with, and the abrupt and dogmatic presentation of the author's opinions on these problems, give to this book a characteristic personal touch which, whilst inviting, at the same time disarms, criticism—a most interesting little book.

Osteomyelitis and Compound Fractures and Other Infective Wounds: Treatment by the Method of Drainage and Rest. By H. WINNETT-ORR, M.D., F.A.C.S., Chief Surgeon of the Nebraska Orthopædic Hospital, etc. Medium 8vo. Pp. 208, with 54 illustrations. London: Henry Kimpton. 21s. net.

FOR many reasons this book is a most noteworthy addition to surgical literature and teaching. In the first place, it is evidently the expression of an honest and earnest worker's whole mind and soul. Secondly, it is the outcome of much patient work and observation begun during the strain and stress of war and continued since. The main principles enunciated have been put in practice for seven years by the author, and for the past few years by many others. Thirdly, it advocates methods of treatment which revolutionize our ideas and which if true will ease the suffering of patients and relieve the surgeon of much thankless work.

The Orr method of treatment is the application to infected wounds, especially of the bones and joints, of the principle of thorough antiseptic cleansing, absence of any suturing—the wound being left widely open and packed with sterilized vaseline gauze—prolonged and absolute rest obtained by fixing the whole limb and, if necessary, the trunk in a plaster case, and leaving the wounds untouched for long periods —that is, for about a month or six weeks. Dr. Orr seems to be much more concerned in claiming that his method is founded on well established principles than in suggesting that he has introduced any innovation or violated orthodox teaching. He labours long and anxiously to prove that he is only carrying out the pure teaching of Lister's gospel. In this we confess we are not convinced, but equally we are not much concerned.

To describe the Orr method as that of 'drainage and rest' entirely fails to indicate its essential features, which are the non-suture of the wound, the use of vaseline gauze as a drainage material, and the sealing up of the limb in a plaster case which is unopened for several weeks. In the treatment of open infected fractures the patient is placed on a traction apparatus and the fracture fully and accurately reduced. Then adhesive plaster or skeletal transfixion is applied so as to maintain the corrected position after the plaster has been put on. The open wound is cleaned with iodine and then spirit, left widely open, and packed with vaseline gauze. The whole limb, including the joints above and below the fracture, is put up in a plaster case to which are attached the transfixion pins or traction bands. Nothing more is then done for four to six weeks. It needs no argument to establish the advantage of this method if it can be carried out safely, for it will not only save the pain and worry of daily dressings, but also may allow the patient to return home between the monthly re-application of plaster and dressings.

It is admitted that these infected limbs usually develop a marked odour before the time comes to change the dressing, and in some cases there is actually a trickling out of discharge from the plaster splint, but this does not affect the main points, which are that the patient has no pain or temperature, and that the wound closes and heals

by granulation much more smoothly and rapidly than when it is subjected to daily dressings.

Dr. Orr has treated over thirty cases of osteomyelitis, both acute and chronic, and many open fractures by this method ; others who write of their experiences in the last chapter have treated many more. Therefore it is not for us to say that the whole thing is preposterous, and the method disgusting. It is surely a case in which we would be wiser to follow the Hunterian advice, " Don't think, but try." We heartily congratulate Dr. Orr on a brilliant piece of work and a most convincing exposition, and we confidently look forward to the time when his method will be acclaimed as a real and epoch-making advance in the treatment of the infected wounds of bones and joints.

Diseases and Deformities of the Spine and Thorax. By ARTHUR STEINDLER, M.D., F.A.C.S., Professor and Head of the Department of Orthopædic Surgery of Iowa State University Medical School. Super Royal 8vo. Pp. 573, with 76 plates. 1929. London : Henry Kimpton. 52s. 6d. net.

THIS book is the work of a surgeon who has made a great reputation as a teacher in his special field. The author's aim has been to expound the anatomical, embryo-logical, and physiological principles concerned in the pathogenesis and treatment of the various affections of the spinal column and thorax, rather than to write a conventional practical treatise. In this he has attained undoubted success, and for many years to come his scholarly monograph will be a valuable and necessary work of reference for all surgical teachers.

The subjects presented with the greatest mastery are naturally those on which the author has carried out personal investigations. Of these the chapter on scoliosis is perhaps the outstanding feature of the book. The subject is approached in a somewhat novel fashion, and we are spared the lengthy pages dealing with the 'museum' pathology of this deformity which still occupy considerable space in most text-books of orthopædic surgery. We find ourselves convinced by the logical deductions of the writer that the structural element in scoliosis is not amenable to true correction, and that the only rational method of treatment is to attempt to re-aline the body by the development of compensatory curves in the movable part of the spine. A mass of information has been collected and analysed on congenital deformities of the spine and thorax, and the subject for the most part has been reduced to simplicity. There are, however, certain omissions which call for comment. Thus spina bifida occulta is described in full detail, but there is no complete account of the various types of hernial protrusion of the spinal contents in spina bifida vera. This omission is intentional on the part of the author, but we would suggest that the advanced student will expect to find the information in a monograph of this type. The account of cervical rib is less happily conceived ; in an otherwise com-prehensive bibliography there is no mention of the work of the anatomists Wood Jones and Wingate Todd. The impression is also conveyed that the vascular symptoms of cervical rib are due to actual mechanical constriction of the subclavian artery ; furthermore the mechanism of the nerve trunk irritation is explained rather vaguely. We would refer the author to Sir Percy Sargent's illuminating contribu-tion on this subject published in Brain in 1921. In the long and excellent chapter devoted to fractures and dislocations of the spine, a more extended discussion on the mechanics of spinal injuries as a whole would be useful. The description of fractures of the upper two cervical vertebræ is also rather scanty. We miss refer-ences to the writings of Sicard, Osgood, and Jefferson. Pott's disease is allotted ample space, and in the discussion on treatment the author once more shows his ability to submerge mere technical details in the exposition of principles. His conclusions on the rôle of fusion operations, which he regards as beneficial only when they do not encroach on the accepted period of recumbency, will be supported by most judicial minds. We note with surprise, however, that the wealth of knowledge embodied in the monograph of Mme. Sorrell-Déjerine on Pott's paraplegia has not been utilized.

Professor Steindler's book is generously illustrated, largely from his own clinical and radiographic material. Every chapter has an extensive bibliography. In the latter the references to American and Teutonic literature are most abundant. This is a boon to the surgical student who is not well versed in the German language, but we find that in many subjects important British contributions seem to have been overlooked.

Tumours arising from Blood-vessels of the Brain. By HARVEY CUSHING, Professor of Surgery, Harvard Medical Schoo'. ⸴ ⸫ ⸫ f, Peter Bent Brigham Hospital, Boston; and PERCIVAL BAILEY, \ ⸴⸴ of Surgery (Elect), University of Chicago. Royal 8vo. Pp. 219 + x, with 159 illustrations. 1928. London: Baillière, Tindall & Cox. 34s. net.

THIS is an important monograph based upon the study of 29 instances of tumour arising in connection with the blood-vessels of the brain which have been met with by the authors. These rare tumours, constituting but 2 per cent of the intracranial neoplasms in a series of some 15,000 cases, are classified and tabulated on the lines with which students of Cushing's writings are familiar. The names applied to these particular tumours are those in general use, in contrast with the nomenclature employed by Cushing for intracranial tumours in general, in which the names are derived sometimes from the histology of the tumour, and sometimes from the anatomical structure from which they arise. The position of angiomata generally in relation to true neoplasms has never been satisfactorily settled, and the authors take the wise course of dividing their cases into : (1) Those which, although capable of growth and other changes that may result in a clinical picture indistinguishable from that caused by a true neoplasm, may be considered as but developmental anomalies of blood-vessels ; (2) Actual neoplasms arising in the 'vaso-formative' or 'angio-blastic' cells. The book is, therefore, divided into two parts embracing respectively these two groups of cases.

The first half deals with six cases of venous angioma and nine of arterial angioma, the symptomatology and therapeutic aspects being discussed in considerable detail. As regards operative treatment, the authors' experience would seem to accord with that of other surgeons who have happened to expose these formidable lesions at operation. In the case of the venous angiomata the dangers, both as regards hæmorrhage and cortical damage, are fully emphasized, and the conclusion that they are best left alone seems justified, though the possibilities of 'electro-surgery' and radiotherapy are mentioned. It is perhaps disappointing to find so little said of the effects of carotid ligation in the cases of arterial angioma, but it seems clear from the authors' experience that there is not much to be expected from this line of treatment.

The second half is concerned with the very interesting subject of cerebellar hæmangioblastomata, the type of tumour which formed the subject of a memorable monograph by A. Lindau in 1927. The authors have encountered thirteen examples of this form of tumour, the histories of which are set out in detail. They constitute a group of cases of great interest from many points of view, one being the practicability of complete surgical removal with but little operative risk. The authors' experience accords with Lindau's observations that these hæmangioblastomata may be associated with angiomata or angiomatous cysts elsewhere, and that this disease possesses familial tendencies.

Recent Advances in Surgery. By W. H. OGILVIE, F.R.C.S., Assistant Surgeon, Guy's Hospital. Second edition. Pp. 495, with 115 illustrations. 1929. London: J. & A. Churchill. 15s.

THE appearance of a second edition of this book a little more than one year after the first fully justifies the praise which we ventured to bestow upon it in our former review. Perhaps as our remarks then were entirely laudatory, we may be permitted on this occasion to be a little more critical.

The chief addition to the work which marks the present issue is an account of radium in relation to the treatment of malignant disease. Carter Braine writes on the physics of radium and X rays, and gives a clear account of the methods of application of these therapeutic agencies, with a description of their employment in conditions other than malignant disease. But this chapter contains a description of the treatment of rodent ulcer which we think is unduly optimistic. It is quite true that a large measure of success has been achieved in the treatment of rodent ulcers by radiotherapy; but general surgeons have become so painfully familiar with those cases which have not been so cured, even after many applications of radium, that we think more might have been said as to the limitations of the method. The following chapter—on radiation and surgery in the treatment of cancer—is by Ogilvie himself, and begins by referring to the brilliant results reported in 1928 at the International Conference on Cancer in London. The whole article is very well balanced, and, whilst full credit is given to the good work done in France, Belgium, and Great Britain in the treatment of cancer of the tongue, breast, and rectum, a warning is repeatedly sounded, that undue optimism may not lead to disappointment or failure: "British surgery having neglected radium in the past, appears to be ready to accept it to-day with a simple faith that pays more homage to Tennyson than to truth. Many of our surgeons speak in terms of unrestrained optimism; but it must be remembered that they have no facts and no figures, and when, in five years time, their accounts come to be audited, much of what they have written to-day will look extremely foolish. There is every indication of the approach of a wave of radium hysteria, like that which discredited psycho-analysis in the years following the war, or the boom in sunlight treatment which is just passing its zenith." The treatment of cancer by lead and its derivatives is dismissed with curt condemnation.

Turning back to look at the book as a whole, we are struck with two chief failings. The one is that it is too much a record of British and American work, whereas the reader is naturally anxious to be informed more fully about what French and German workers are doing. The other is that the section dealing with bones, joints, and orthopædic work is far behind the standard of the rest of the book. We are the more surprised about this as the author is himself so interested in orthopædics and has introduced a very good and new motor instrument for cutting and boring bones. The section on fractures contains nothing but the dullest platitudes; bone-grafting we are told was originated by Macewen but nothing else either new or interesting, and the surgery of congenital dislocation of the hip does not appear to have made any advances either in diagnosis or treatment since the first edition was published. Finally, we should have thought that the author might have known better than to write of Butlin as " Sir Thomas " !

Die Chirurgie. A System of Surgery. Edited by Professors KIRSCHNER (Tübingen) and NORDMANN (Berlin). Fasc. 24, being a part of Vol. II. Royal 8vo. Pp. 161, with 43 illustrations in the text and 5 coloured plates. 1929. Berlin and Vienna: Urban & Schwarznberg. M. 10.

THE present number is concerned with the heart and pericardium (Professor Rehn), and the arteries and veins (Professors Stich and Gaza). A short account is given of the recent work on the physiology of the heart, and the possibility of testing its functional efficiency before operation is discussed, but the methods given are described too briefly for any practical value. Direct massage through the abdomen, and the injection of 1–1000 adrenalin solution, are considered the best methods of restoring the heart failure which sometimes occurs suddenly during narcosis. The position of the heart, the normal variations from this position, and the effects of displacement by tumours and disease are given in some detail. Gunshot wounds of the heart are described, but there is a disappointing absence of detail or illustration in regard to the technique of exposure and suture of the organ.

The operation of cardiolysis, by which the adherent heart is freed from its anterior anchoring, is spoken of in terms of commendation, and it is claimed that it

has only a trivial mortality, whilst nearly three-quarters of all patients are relieved by the procedure. The very short dismissal of operations upon the cardiac valves would indicate that not much is expected along this line of surgical advance.

The chapter dealing with injuries and diseases of the blood-vessels does not call for any special comment. The various operations for aneurysm are described, but the more complicated ones—for example, those of Matas—can hardly be understood in the absence of illustrations.

Phlébites, Thromboses, et Embolies post-opératoires. By J. DUCUING, Professeur agrégé à la Faculté de Médecine de Toulouse ; Chirurgien en Chef des Hôpitaux. Preface by Professor J.-L. FAURE. 1929. Paris : Masson et Cie. Medium 8vo. Pp. 512, with 65 illustrations and 16 temperature charts. Fr. 60.

THIS volume is stated by the author to have been written with two chief objects, first to supply a convenient work of reference on the subject for the use of surgeons, and, second, to report some of his own clinical observations and laboratory researches.

Under etiology the various factors usually considered to be of importance are mentioned. Like most surgeons, he finds abdominal operations especially liable to cause these conditions. Pages 83–209 are devoted to the classification and descrip-tion of the various clinical guises under which post-operative thrombosis may be encountered. Briefly, the author's point is that thrombosis is much more common after operation than is usually believed—for example, he finds it in one out of every ten abdominal cases—but that the majority of surgeons miss the sometimes delicate signs of the condition, or interpret them in other ways. Especially is this so, he believes, in the case of abdominal and pelvic thromboses, and he is of the opinion that a large number of cases with post-operative urinary troubles, slight abdominal distension, and rectal discomfort are really examples of thrombosis : he enumerates signs by means of which such thrombi may be recognized, among which may be mentioned slight œdema over the pubis or of the labia majora, the presence of tender areas on rectal or vaginal examination, and unexplained slight elevations of the temperature and pulse. Post-operative embolism, too, he believes to be an exceedingly common complication, in 3000 cases finding no fewer than 300 examples, of which only 19 were of the fatal massive type. A large number of the post-operative complications met with in the chest are considered to be embolic in origin.

Pathological questions are discussed under the usual three headings of slowing of the circulation, modifications in the blood, and alterations of the vein wall. But, as would be expected from the French school, most stress is laid on the last factor, in the production of which sepsis is considered to be of paramount importance.

Treatment is divided into prophylactic, and that of the developed condition. Under the former, the author makes especial mention of the pre-operative use of vaccines. He is not in favour of too early rising after operation, preferring to trust rather to such exercises as may be carried out in bed. A very careful watch for the earliest signs of phlebitis is advocated, so that rest may be enjoined and embolism thus avoided.

How far has the author succeeded in the objects for which the book was written ? In the preface, Faure concludes : " Je ne crois pas qu'il soit possible de tourner et retourner un sujet plus complètement." Without necessarily agreeing with this verdict, we feel that this process may have been somewhat overdone, and that the work might with advantage have been considerably reduced in size. Moreover, the author occasionally seems to forget that personal opinions unsupported by facts do not constitute evidence. Thus, when he states that the large majority of thrombi are infective, but that the infection is, as a rule, not exogenous but endogenous, he may or may not be correct, but he is certainly not giving the critical observer any grounds for accepting his conclusions. The book contains several passages where such uncorroborated statements of opinion are given the value of proven facts, a

feature which constitutes one of its weaknesses. The experimental part of the work deals with the coagulation produced by the intravenous injection of sodium salicylate. While these experiments are of intrinsic interest, it is rather doubtful whether the condition resulting from the intravascular injection of such caustic substances is comparable with post-operative thrombosis. It is in the clinical sections that the most interesting material will be found, and, though they may find much there with which they cannot agree, surgeons are likely to derive food for thought from a critical survey of this part of the work. The bibliography is extensive, over 300 references being given, but we find no mention made of Welch's classical article on thrombosis in Allbutt's *System of Medicine*, while Lister's statistical inquiry into pulmonary embolism is also missing.

Movable Kidney : Etiology, Pathology, Diagnosis, Symptoms, and Treatment. By WILLIAM BILLINGTON, M.S. (Lond.), Ch.M. (Birm.), F.R.C.S., Senior Surgeon, Queen's Hospital, Birmingham : Professor of Surgery, University of Birmingham. Second edition. Post 8vo. Pp. 177 + ix, with 14 full-page plates and illustrations *in the* text. 1929. London : Cassell & Co. Ltd. 12s. 6d. net.

THE second edition of this book is excellent. Pyelography in the upright position is a distinctly sound contribution to the diagnostic armamentarium. The subject is treated very thoroughly, and obviously the author is sincere in his belief in (1) the frequency of movable kidney as a cause of symptoms, and (2) the efficacy of *fixation* as treatment.

Now, the truth about nephropexy is roughly that, first it was done, then it was overdone, and now it is possibly being underdone, because of the extravagant claims made for it as a cure for insanity and other remote conditions. There is no doubt : ˙ ˙ M . B˙˙˙˙ˤ˙˙˙ has perfected the technique of nephropexy. We have seen the B ˙˙ ˙˙ ˙ ˙ ˤ at work ; and if a kidney should be fixed, it should be fixed by Mr. Billington's method ; but we cannot help wondering why it is that other surgeons, both general and those with a strong leaning to urology, do not meet *so* many cases as Mr. Billington meets in Birmingham.

Further, the removal of the appendix in every case, though no doubt advisable, simply ruins his 1500 cases regarded statistically. Appendicitis is so common, and so commonly responsible for many of the symptoms attributed by Mr. Billington to movable kidney, that the series cannot be regarded as final until Mr. Billington has another series without removing the appendix, *in those cases where there is no* definite reason for appendicectomy. It will be remembered that Edebohl, of kidney pillow fame, always removed the appendix when he fixed a kidney. *Does not this* show some slight lack of faith in the ostensibly primary operation ?

One cannot help thinking of what Dr. Johnson said when he first heard a woman preaching, curiously enough at *Birmingham*. He said, " It reminds me of the dancing dog ; the marvel is not so much that the dog does it well, but that the dog—an otherwise intelligent animal—thinks it worth while doing at all."

Spinal Anæsthesia (Subarachnoid Radicular Conduction Block): Principles and Technique. By CHARLES H. EVANS, M.D., Clinical Assistant, New York Post-Graduate Medical School and Hospital, etc. *With an Introduction by* W. WAYNE BABCOCK, M.D., F.A.C.S., and a Foreword by CHARLES GORDON HEYD, M.D., F.A.C.S. *Medium* 8vo. Pp. 203 + xxii, with 41 illustrations, 3 *in colour, and 1 folding coloured plate.* 1929. New York : Paul B. Hoeber, Inc. $5.50.

THERE has undoubtedly been a recent revival of interest in spinal anæsthesia, owing to the employment of less toxic drugs, and to marked improvements in technique by which the extent of the anæsthesia can be fairly well controlled. By the judicious use of adrenalin and ephedrine the marked fall of blood-pressure which proved rather alarming with stovaine can be avoided. At the recent annual meeting of the British Medical Association in Manchester the subject of spinal anæsthesia was discussed

at the Section of Anæsthesia, and great interest was evoked in the exposition by Dr. Pitkin, of Haversack, New Jersey, and Dr. Frank Kelly, of Detroit, of their methods of ' controllable spinal anæsthesia' with ' spinocain', which are described in the present volume.

Dr. Evans states concisely and fairly the indications for the use of spinal anæsthesia, its advantages and disadvantages, and the special precautions conducive to its successful application. As Dr. Wayne Babcock, in an introductory note, states, "It is a very personal method, strongly appealing to the temperaments of many operators, but equally unadaptable to others". Dr. Evans describes in full detail only one technique—that which has served him well in 1000 cases. Prior to the introduction of the anæsthetic solution into the subarachnoid cavity, in order to counteract the fall of blood-pressure he prefers adrenalin to ephedrine, and injects intramuscularly, into the buttocks, 1 min. of a 1–1000 solution of adrenalin for every 15 lb. of body weight. After discussing the relative merits of cocaine, tropacocaine, stovaine, apothesine, and novocain, Dr. Evans decides in favour of a preparation of novocain known as neocaine. The technique of introduction of the anæsthetic solution is fully detailed, and in Chapter 5 the accompanying phenomena—extent and duration of the anæsthesia, the fall in blood-pressure, the slowing of the heart, the respiratory depression, the lumbar puncture headache, and the increased peristalsis—are all physiologically explained.

The recognition of complications and the measures employed for their prevention are well described, and the causes of failure carefully analysed. Though Dr. Evans is obviously an enthusiast and views the subject through rose-tinted spectacles, yet his book is a most valuable contribution to a subject of great and increasing importance at the present time. The work is well illustrated.

The Treatment of Fractures and Dislocations in General Practice. By C. MAX PAGE, D.S.O., M.S. (Lond.), F.R.C.S., Surgeon to St. Thomas's Hospital, etc. ; and W. ROWLEY BRISTOW, M.B., B.S. (Lond.), F.R.C.S., Surgeon to the Orthopædic Department, St. Thomas's Hospital, etc. Third edition. Demy 8vo. Pp. 284 + xiii, illustrated. 1929. London : Oxford University Press. 14s. net.

THIS edition differs from the second only in being slightly larger. Its chief improvement is the introduction of very clear line drawings alongside the X-ray reproductions which are not very clear. We cannot help thinking that the substitution of similar line drawings for all the X-ray photographs would be an improvement. The main feature of the book is that it follows the practice of the authors, and, as such, illustrates clearly the uses and limitation of plaster-of-Paris in the treatment of fractures. When dealing with this form of treatment, the writing is direct and the note sure, but the descriptions of, and indications for, most kinds of splint treatment are not so good.

The chapter on the operative treatment of fractures is most disappointing. While in a book written for the use of general practitioners no details of the various methods in use should be included, we cannot help thinking that the authors have not realized the importance of impressing upon the general practitioner the principle that early operative treatment is absolutely essential for certain fractures. This particularly applies to intra-articular fractures, and fractures of such bones as the carpal scaphoid. The latter is not mentioned in the chapter devoted to operative treatment, and where it is dealt with, the prognosis and advice as to operative treatment are very undecided. We cannot agree that open reduction without internal fixation has a somewhat limited application. When writing that the chief indication for its use is a fracture-separation of the lower epiphysis of the humerus, it is to be concluded that a supracondylar fracture is meant, as there is no detailed account of epiphysial separations.

It is unfortunate that the only two radiographs showing the application of Lane's plates demonstrate appalling results. We cannot help thinking that a more clear-cut description, founded upon personal experience, of the indications for and use of open reduction would have been of great use to many practitioners. We

cannot agree with the statement on page 110, that fractures about the elbow should be treated in a position of 40 degrees flexion. No warning is given in connection with the treatment of these fractures of the danger of immediate reduction and fixation in flexion. The authors have not yet realized the educative value of reduction of most fractures under an anæsthetic on the X-ray table. Six months' experience of the treatment of elbow fractures under these conditions would convince them that once reduction has been obtained, fixation in full flexion is usually unnecessary.

We cannot see 'eye to eye' with the authors in preferring to pass a pin for axial traction over, rather than through, the os calcis ; and similarly, we cannot help thinking that their unfortunate experience of transfixion of the condyles of the femur by a pin for axial traction has been unusual. These are, of course, only minor differences of experience.

The treatment of fractures of the spine with cord injuries is so largely the prevention of renal infection, that something more than a few lines would be helpful in contrasting the different treatments for retention. This section of the book suffers from being much condensed.

On the whole, the book will serve its purpose. It is for the most part candid and practical, so that in many respects it satisfies the needs of a practitioner faced with a difficult fracture. As a rule space is given to consideration of common injuries, both in letterpress and figures. We are confident that this edition will have as brief, and as successful, a life as the last.

Le Diagnostic dans les Affections de la Colonne vertébrale (chez l'adulte). By Professors P. OUDARD, A. HESNARD, and H. COUREAUD (Toulon), with a Preface by Professor SICARD. Medium 8vo. Pp. 256, with 75 illustrations. 1928. Paris : Masson et Cie. Fr. 36.

THIS small monograph represents chiefly the application of modern methods of diagnosis to the problems of disease or deformity of the spine. Radiology and the information derived from the injection of lipiodol now represent the last word in accurate diagnosis of the nature, position, and extent of lesions of the vertebral column. The instinct of the clinician and his interpretation of physical signs and symptoms are now to be supplemented by the precise information derived from modern scientific methods.

The main part of the work, descriptive of normal anatomy and the morbid changes associated with tuberculous disease of the spine, is of great value, because of the simple and clear descriptions and the excellent line drawings and diagrams. The reproduction of actual X-ray pictures is not as clear as might be wished. For this reason the description of deformities of congenital or postural character is not so valuable as might be desired. This is unfortunate because it is in just such conditions as sacralization of the 5th lumbar vertebra, and its distinction from osteoarthritis, that one would naturally turn to such a monograph as this for help.

Some Principles of Minor Surgery. By ZACHARY COPE, M.S., M.D. (Lond.), F.R.C.S., Surgeon to St. Mary's Hospital, Paddington, and to the Bolingbroke Hospital. Post 8vo. Pp. 159 + xi, with 82 illustrations. 1929. London : Oxford University Press. 10s. 6d. net.

THIS book is a collection of eight papers dealing with surgical principles or certain subjects of minor surgery. The use and abuse of antiseptics is the first of these essays and in it is given a good critical account of the modern application of Listerian principles. The chief value of antiseptics in wound treatment is in dealing with grossly infected superficial wounds soon after their infliction. Acriflavine and Dakin's solution are esteemed to be of the most value. In discussing the treatment of acute inflammation and describing common mistakes in the diagnosis and treatment of acute abscess there is not much that calls for comment. The fourth chapter

is concerned with infections of the fingers, and due importance is given to Kanavel's work. By means of superimposed transparent films useful diagrams are given showing the relation of the palmar connective-tissue spaces to the better defined structures of the hand. Chapters 5 and 6 describe sprains and the ambulatory treatment of fractures. So many different injuries are described, and these so briefly, that it may be questioned whether these chapters are of great practical value. For instance, the so-called sprain of the sacro-iliac joint is dealt with in less than one page, and sacrolumbar sprains in an even shorter space. In injuries of the shoulder and humerus the value of an abduction splint is not mentioned, although this is surely the most important appliance in many such conditions. In speaking of supra-malleolar and malleolar fractures, it is perhaps unfortunate that, although in the text it is mentioned that the foot should be placed at right angles to the leg, yet in all the pictures of the plaster-of-Paris splint and its application, the foot is shown in a dropped position.

The next chapter describes the treatment of retention of urine, due to an enlarged prostate, by means of catheters or suprapubic puncture of the bladder, and very great stress is laid on the importance of emptying the distended bladder gradually. The concluding chapter deals with a variety of minor operations—for example, varicose veins, ingrowing toe-nail, and the removal of foreign bodies. We think the book would make a greater appeal if it dealt more with principles and less with details.

A Graphic Guide to Elementary Surgery. By Professor TH. NAEGELI, Bonn. Translated by J. SNOWMAN, M.D., M.R.C.P., with an Introduction by Dr. C. GARRÉ, Bonn. Royal 8vo. Pp. 206, with 322 illustrations (mostly coloured). 1929. London : John Bale, Sons & Danielsson Ltd. 12s. 6d. net.

THIS elementary picture-book of surgery is founded on the assumption that "a picture is worth more than many a thousand words", and has an introduction by the late Professor Garré explaining its purpose of impressing facts on the mind and memory by pictorial representation. We confess that the ideals aimed at have made a strong appeal to us and that we have derived much interest, and may we say amusement, from reading it. It deals only with general principles : anæsthesia, infections, wounds, injuries of bone, tumours, affections of arteries and veins, metabolic disorders, operations, grafting, and methods of examination. The main feature of the book is the composite diagrams—for example, *Fig.* 130 tells the story of pyæmia by means of a temperature chart, a diagram of the infected wound and the spread of infection, with others of the lungs, kidneys, liver, and hollow bones.

Certainly such a simple and graphic method of teaching affords a most valuable introductory book for the student or for the nurse. The method might with advantage be extended for use in a larger text-book.

Kleine Chirurgie. By Professor HANS KURTZAHN, Königsberg. Medium 8vo. Pp. 475 + viii, with 172 illustrations and 1 coloured plate. 1929. Berlin and Vienna : Urban & Schwarzenberg. Paper covers, M. 20 ; bound, M. 22.

THIS exposition of minor surgery is carried out on the usual lines of such books. Probably no two authors would agree as to the selection of subjects to be included in, or excluded from, the scope of such a work. In the present case the chief principle consists in excluding abdominal surgery or any description of major operations. Curiously enough, the one coloured plate is devoted to the illustration of a very rare condition, viz., erysipeloid affecting one finger. The description of ordinary matters of surgical technique is simple and clear. Injuries and infections of the fingers receive considerable attention, but there is no clear account of the connective-tissue spaces of the hand. The last chapter, which forms an unusual feature of current text-books, deals with prognosis after accidents, with a special view of giving expert opinion in cases arising under the Workmen's Compensation Act.

Hæmorrhoids: their Ætiology, Prophylaxis, and Treatment by means of Injections. By ARTHUR S. MORLEY, F.R.C.S., Late Temporary Assistant Surgeon, St. Mark's Hospital for Cancer, Fistula, and other Diseases of the Rectum. Fourth impression, revised and enlarged. Demy 8vo. Pp. 122 + viii, illustrated. 1929. London: Humphrey Milford. 6s. net.

WITH the exception of an additional chapter at the end of the book entitled "An Improved Technique" in which the author adopts the method practised by the late Dr. J. D. Albright, of Philadelphia, and by Dr. C. Elton Blanchard, of Youngstown, Ohio, this book is practically a reprint of the former edition. We have, therefore, no further comment to make upon it except to express our regret that the author has not seen fit to delete the sentence against which we then took umbrage.

Injection Treatment of Internal Hæmorrhoids. By MARION C. PRUITT, M.D., Associate in Surgery, Medical Department, Emory University, Georgia Baptist Hospital and Grady Hospital, etc. Crown 8vo. Pp. 137, illustrated. 1929. St. Louis, U.S.A.: The C. V. Mosby Company. 12s. 6d. net.

THIS small volume, we are told by the author in his preface, represents an attempt to set down his experience with, and to show the val˙ ˙ ˙ ˙ ˙ treatment of internal hæmorrhoids. After defining the term · · opening chapter, the author endeavours in the succeeding one to furnish the reader with a working knowledge of the surgical anatomy of the anus, anal canal, and the lower part of the rectum. Our comment upon this chapter is that these anatomical details will be found to have been more accurately described in any text-book of anatomy. Chapter 3 deals with etiology and prophylaxis ; the influence of occupation, age, sex, and heredity is also cursorily discussed. Chapter 4 represents the author's interpretation of the pathological changes which Quénu states take place according to his investigations. Chapter 5 contains a schematic arrangement in the form of a chart which is suggested as a substantial basis for the classification of hæmorrhoids. According to the author's preface, one of his reasons for writing this book was to remedy the confusion that he considers to exist in the minds of the medical profession with regard to the injection treatment of hæmorrhoids, but we are afraid that the classification which he now suggests will make confusion even worse confounded. Chapters 6 to 9 are devoted to the classification of both external and internal hæmorrhoids, their symptomatology, and their diagnosis. Chapter 10 is concerned with sphincteroscopes. Chapter 11 is replete with the opinions expressed by various authors in published papers upon the method of treating hæmorrhoids by injections. Chapter 12 describes the different solutions used by various exponents of the injection method, together with the author's technique for carrying out the treatment. The remainder of the book contains chapters upon care, after-treatment, pathological changes produced by injections, advantages and disadvantages of the treatment, contra-indications, complications, recurrences, and illustrative cases.

We can find no word of praise for this book. It is full of inaccuracies, the names even of well-known authors not escaping mutilation, as, for example, when Sir Charles Gordon-Watson's statistics are attributed to Sir Gordon Eatson.

The Injection Treatment of Varicose Veins. By A. H. DOUTHWAITE, M.D., M.R.C.P., Assistant Physician, Guy's Hospital. Fourth edition. Crown 8vo. Pp. 58 + x. 1929. London : H. K. Lewis & Co. Ltd. 4s. net.

THE author, after an experience of five thousand injections, is more than ever convinced of the great value of this method in the cure of varicose veins. Having tried various alternative solutions, he considers that the quinine and urethane solution is the best. It gives uniformly good results and produces a venitis with more firmly adherent clot than any other drug. Injection is not recommended for the treatment of varicocele.

Imperative Traumatic Surgery, with Special Reference to After-care and Prognosis.
By C. R. G. FORRESTER, M.D., F.A.C.S.. Consultant, Teaching Staff, Illinois Post Graduate School, Laboratory of Surgical Technique, Chicago, etc. Medium 8vo. Pp. 464 + xxix, with 598 illustrations. 1929. London : William Heinemann (Medical Books) Ltd. 42s. net.

THERE is nothing remarkable in this book beyond the title. Whilst it deals chiefly with fractures, dislocations, and injuries of peripheral nerves, it also includes housemaid's knee and acute osteomyelitis. In the case of fractures of the skull, spine, chest, and pelvis, the possible concomitant injuries to brain. spinal cord, and viscera are only briefly mentioned.

When we are told that after removal of a semilunar cartilage from the knee the patient should be able to walk without the use of an artificial support in from five to eight weeks, and that for traumatic synovitis the treatment should be immobilization of the limb in a plaster cast for six weeks, we can but regret that the hustle characteristic of American life has not been universally adopted by ' traumatic surgeons'.

Lister Redivivus. An Essay on the Undue Prevalence of Sepsis. By A. C. F. HALFORD, M.D., Honorary Consulting Surgeon. Lady Lamington Hospital, Brisbane. Royal 8vo. Pp. 110. 1928. Brisbane : Sapsford Bros. 5s. net.

THE history of the methods of treating wounds and of the antiseptic principles of surgery is a fascinating one, the epic of which still remains to be written. The beginning of the story is vague and nebulous and goes back to times earlier than our earliest records : it continues through the centuries, and even to-day universal agreement on this fundamental subject has not been reached.

More than 600 years ago, before the Battle of Crécy was fought, a famous French surgeon, Henri de Mondeville, affirmed his belief, which amounted in those days almost to heresy, that suppuration was not an essential process in the healing of a wound, and that wounds could, and did, heal by first intention, if treated by the methods he advocated and gave to the world in his book on surgery. The main principles of Mondeville's treatment, the exact reasons for which he did not appreciate, were to remove all foreign bodies from the wound, to avoid probing, to wash it with wine, to avoid exposure to the air by means of early suture, and then to cover it with compresses soaked in wine. The introduction of this novel treatment, which compares very favourably with modern aseptic principles, seems to have caused an immense commotion in medical circles. Mondeville says himself that he had much to put up with, vehement discourses, violent words, perils, and menaces so threatening that he would have abandoned it if he had not had the support of his royal patron, the Count of Valois.

It would appear that Mondeville's method was not his own, but taken from his master, Theodoric, and then elaborated and improved. But where did Theodoric get it ? The answer is not given, but the story of the Good Samaritan suggests that something like it had existed for many years. After the death of Mondeville the method was abandoned, and the great Guy de Chauliac, writing fifty years later, speaks of it with disdain. So 600 years elapsed before the illuminating discoveries of Pasteur, and their application to surgery by Lister, gave to the world the true knowledge of the cause of suppuration, and made surgery safe. These epoch-making discoveries ushered in the era of antiseptic surgery, soon to be followed by that of aseptic surgery. This great revolution, though, did not come peacefully. The doctrines of Lister were not adopted quickly and universally. Antisepsis and asepsis : the controversies on these raged to and fro, until the clouds of confusion gradually cleared, and the true meaning of the difference, or want of difference, between the methods has become evident and the medical profession has settled down with complacency to what has become an international standard method.

Now Mr. Halford, in his book *Lister Redivivus*, wonders what Lister would think if he were to come to life again and see how different the methods at present in

vogue arc from the ritual he elaborated. He thinks Lister would be sad, miserable, shocked, for in his opinion the world has adopted an unsound, fallible method instead of a sound one. His thesis is that there is too much and avoidable sepsis in surgery and midwifery, all of which could and should be avoided by adhesion to Lister's own methods. From many of Mr. Halford's opinions we may dissent ; we may be irritated by his methods of argument, for he hits out hard and often, but at the same time we thank him for calling attention to a most important subject, and for the obvious sincerity and honesty of purpose which shine out from every line. The author is a man of mature age who has been for many years a general practitioner and Medical Officer of Health in Australia, and he speaks out of the fullness of his experience. His book also is introduced by Mr. Hamilton Russell, whose opinion is universally respected, who says of him in a Foreword that " it is the cry of a thoughtful and enthusiastic practitioner of medicine, prompted, I may even say goaded, to a divine discontent at the present-day usages that purport to be the modern and improved expositions of the principles of Lister."

It is not an easy book to read or review because of a lack of clear exposition, which engenders confusion of thought in the mind of the reader and, may one guess, in the mind of the writer as well. The subject raised, however, is so important, and such serious criticism is levelled at the methods at present in vogue, that the book has been read with the care it deserves and, as far as possible, without prejudice.

If we have understood the author aright, the following are the points he makes : (1) There is undue sepsis in medical practice to-day : operation wounds 'go wrong': contaminated or infected wounds, which might have been cleansed by Listerism, are allowed to suppurate : tuberculous abscesses become secondarily infected and parturient women become infected, many dying, and still more undergoing long and painful illnesses. (2) All these could be prevented by using Lister's methods. (3) The modern usage of dressings and instruments sterilized by heat, and without the use of 'antiseptic' chemicals, does not prevent contamination of the wound, either at the time of operation, or in the post-operative period of dressing and convalescence, or in the puerperal or post-puerperal period.

These seem to be the main arguments employed when dissected out of the mass of observations and objurgations contained in *Lister Redivivus*. If these points are examined it seems clear that most, if not all, will at once agree that there is still a regrettable amount of sepsis. What surgeon can deny that sometimes an operation 'goes wrong' ? What obstetrician can say that he never sees a case of puerperal sepsis in his practice ? Conceding these points, the main argument has to be examined. Would there be less sepsis if all wounds, and all midwifery cases, were treated by Lister's methods, as Lister used them ? Mr. Halford thinks there would. There seems to be a very large body of opinion of a contrary character. Is it not clear that a clean wound is to be kept free from contamination with micro-organisms ? Is it not better to take such steps as will ensure that none get in rather than to kill them once they have got in ? From the point of view of clean operation wounds, surgeons have arrived at the opinion, on good and sufficient grounds, that sterilization of instruments and dressings by heat, and protection from infection of hands and mouth by gloves and masks, give good results.

The treatment of accidental, already contaminated, or infected wounds may be considered more open to argument. Mr. Halford points to the terrible amount of suppuration seen in the Great War, and infers that all the dreadful sights revealed then to military surgeons might have been banished by Listerism. He says : "How powerless aseptic surgery was under these new conditions we can read in the medical records of the Army Medical Services. What is most remarkable about these reports is the ultimate conclusions of the most energetic research workers, that the most that could be done was to subject all infected wounds to continuous irrigation with an antiseptic for long periods." It is true that we were a long time controlling sepsis in war wounds, but this was largely due to the conditions of warfare which compelled wounded to be brought back to the base, and thus delayed treatment for days. In the later stages of the war, things were very different. One of the most

important and fundamental pieces of research was done and published by the late Forbes Fraser: "Primary and Delayed Primary Suture of Gunshot Wounds: A Report of Research Work at a C.C.S." (Brit. Jour. Surg., 1918, vi, 92). This work seems to answer in most respects these criticisms, and though these remarks may perhaps not convince Mr. Halford, they may serve to show him that there is at least another side to the shield. He may be pleased to think that his criticisms may, as they certainly should, cause every surgeon to pause and ask himself if he is doing all he ought. If this results, then the book is justified, and Mr. Halford may be to surgery, as the pearl to the oyster, a precious irritant.

Indigestion: Its Differential Diagnosis and Treatment. By HERBERT J. PATERSON, C.B.E., M.C., M.D., M.A. (Cantab.), F.R.C.S., Senior Surgeon, London Temperance Hospital. Pott 4to. Pp. 153 + viii. 1929. London: William Heinemann (Medical Books) Ltd. 7s. 6d. net.

IN this book the author has endeavoured to present a practical guide to the differential diagnosis and treatment of indigestion. As the book is intended for clinical use and not for historical research, references to statistics, etiology, and pathology have been omitted, except in so far as is necessary for an adequate understanding of the subject. He first of all attempts a classification of disorders of digestion; this is followed by a chapter on clinical investigation in which he rightly emphasizes the outstanding importance of the history. Under the heading of physical examination a good deal of space is devoted to test-meals and their significance, the author believing that in their proper place such investigations are a great help in the diagnosis of the causes of indigestion. We think that he over-stresses the value of test-meals; gastric analysis cannot be other than an inexact bio-chemical procedure, for not only are the normal variations very elastic, but these variations themselves depend on factors which are constantly changing, and of these the psychic factor may be of great importance, depending as it may upon the reaction of the patient to the extreme unpleasantness of the passage of the stomach tube. In the chapters dealing with gastric and duodenal ulcers and cancer of the stomach we find a repetition for the most part of the descriptions to which we have become so accustomed in the literature, and the same may be said of the chapter on complications.

Under the heading of surgical treatment of duodenal ulcer the author asserts that gastrojejunostomy is a physiological operation; we presume he means by this that it is a chemical, as opposed to a mechanical procedure; for an operation which removes the emptying point of the stomach out of the line of the peristaltic drive of the muscle can hardly be termed physiological. We think the value of his assertion would have been enhanced if he had produced arguments to show that the mechanical factor of a new opening has no significance. The book terminates with a short chapter on the general treatment of disorders of digestion, and an appendix in which various tests, qualitative and quantitative, are described.

On the whole the book fulfils its purpose as a practical guide to the differential diagnosis and treatment of indigestion, but we do not think the author is serving any very useful purpose in presenting it. The matter it contains has already been published in book form on very similar lines; there is nothing new in it, and nothing to stimulate thought along fresh channels. The author is so well known as an authority on gastro-intestinal disorders that we confess to a feeling of disappointment that he should have presented a book which does not carry us any farther than we were ten or fifteen years ago.

Chirurgie de l'Articulation temporo-maxillaire. By L. DUFOURMENTEL, Professor of Maxillo-facial Surgery in the Dental School of France. Medium 8vo. Pp. 228 + x, with 69 illustrations. 1929. Paris: Masson et Cie. 6s. 6d. net.

THIS monograph deals with a subject which enters the province both of the general and of the dental surgeon. The temporo-maxillary joint is difficult to examine either

by palpation or by radiographs, and the latter can only be interpreted with difficulty. The diagrams of the anatomy of the joint are good and clear, although the subdivision of the ligaments is depicted as being much more distinct than is really the case. Arthritis, acute or chronic, and trismus are described fully and on usual lines. The most interesting and valuable chapters are those relating to deformities of the condyle, prognathism, and ankylosis. The treatment of prognathism by resection of the condyle on each side is very interesting, but is open to two critical remarks. What is the late result of excision of both condyles? One would like to know the condition, as regards movements and mastication, five years after the operation. The other point is that, judging from the accompanying illustrations, the amount of prognathism was hardly enough of a deformity to justify the operation in some of the cases.

The chapter to which the general surgeon will turn most frequently is that on ankylosis of the joint. The author claims to have operated upon more then fifty cases with only three recurrences. The line of the articulation is cut by means of a number of adjacent drill-holes and the surfaces are smoothed off. No attempt is made to interpose either muscle or foreign material, and the wound is closed without drainage. Great reliance is placed upon the use of an apparatus (Darcissac) by which almost constant immobilization of the jaw is achieved. This consists of two levers fixed to the two jaws and so activated by an elastic spring as to keep the jaws open. The patient will close the jaw in the act of speaking or swallowing, so that the articulation is kept constantly moved.

Branchial Cysts, and other Essays on Surgical Subjects in the Facio-cervical Region. By HAMILTON BAILEY, F.R.C.S., Surgeon to the Dudley Road Hospital, Birmingham, etc. Crown 8vo. Pp. 86 + viii, with 50 illustrations. 1929. London: H. K. Lewis & Co. Ltd. 5s. net.

THIS short collection of essays on subjects relating to the surgery of the neck is of definite practical value. The diagrams of the possible situation and relations of branchial cysts, which have already appeared in this JOURNAL, are clear and simple.

It is rightly maintained that a correct diagnosis can be made in most cases before operation. Stress is laid on the characteristic appearance under the microscope of the fluid withdrawn by puncture. It always contains cholesterin crystals and epithelial débris. A good description is given of the complete operation for the removal of the thyroglossal tract, after division of the hyoid bone. The complications and diagnosis of a submaxillary calculus form the theme of another interesting chapter. The last chapter is on the preventive treatment of cavernous sinus thrombosis in cases of carbuncle of the upper lip. This, consisting in the ligature of the angular vein, was done in four cases, three of which made a good recovery. The subject is one very inadequately dealt with in current surgical text-books, and the present volume is decidedly opportune.

Le Tractus thyréoglosse. By G. RÉMY NÉRIS, Ancien Interne lauréat des Hôpitaux de Paris (Prix d'Otologie). Medium 8vo. Pp. 170, with 23 illustrations in the text. 1929. Paris: Gaston Doin et Cie. Fr. 30.

THIS prize essay brings together in a very convenient and readable form the salient facts about the embryology, pathology, and treatment of cysts, fistulæ, and tumours of the thyroglossal tract. The very intimate relationship of the budding thyroid duct to the hyoid bone in early development is well shown by a number of sections of embryos. This point is of cardinal importance in understanding the persistence of fistulæ and the recurrence after operations upon cysts. It forms the basis of the Sistrunk operation, which is figured and described, the hyoid bone being divided in

order that the whole tract up to the foramen cæcum may be removed. A small quiescent cyst not causing symptoms should be left alone. The drawings and microscopical sections are very clear and convincing.

Gelenkerkrankungen. Einführung in die Pathologie und Therapie. By Dr. ERNST FREUND, Vienna. Royal 8vo. Pp. 497 + xii, with 88 illustrations in the text. 1929. Berlin and Vienna : Urban & Schwarzenberg. Paper covers, M. 32 ; bound, M. 35.60.

THIS book, which aims at giving an introduction to the pathology and treatment of joint disease, is a general survey of the subject written by a physician. He is fully aware of the size of his subject and its many complexities, and he strives to bring together the many workers and the results of their labours in this compact and practical book. It makes no pretensions to be a surgical text-book. In fact there are only two pages devoted to surgical treatment. But the author makes a strong and an unanswerable appeal for closer co-operation between the physician and the surgeon, in order that knowledge of the scope and results of surgical intervention may be better appreciated.

The book is remarkable rather for the large number of subjects with which it deals than for the completeness with which any one subject is discussed. Every possible disease in which the joints are affected is described. The influence of metabolic disorders, nervous diseases, and diseases of the endocrine glands is discussed at some length. There is a summary of all the methods of treatment, with a short indication of the scope of each. The illustrations, which are not very numerous, are good and clear, but their value would be greatly increased by the addition of an appropriate legend to each, instead of compelling the reader to search for the reference in the text.

Die Vor- und Nachbehandlung bei Chirurgischen Eingriffen. By Dr. M. BEHREND. Second edition. Post 8vo. Pp. 115, with 5 illustrations. 1929. Berlin : Julius Springer. M. 4.80.

THE appearance of a second edition of this small and practical book so soon after the first is sufficient evidence that it has been found of value. It is remarkable how much is contained in so small a compass. For this reason and also because of its completeness and simplicity it will probably continue to prove of value to students, nurses, and house surgeons, in reminding them of special precautions to be taken before operations, and special treatment necessary afterwards.

Œsophageal Obstruction : its Pathology, Diagnosis, and Treatment. By A. LAWRENCE ABEL, M.S. (Lond.), F.R.C.S., Assistant Surgeon to the Cancer Hospital, London. Super Royal 8vo. Pp. 234 + xi, illustrated. 1929. London : Humphrey Milford. 30s. net.

THIS book incorporates the Jacksonian Prize Essay of 1925 revised, enlarged, and brought up to date, and a Hunterian Lecture delivered in 1926. It is well and profusely illustrated, and is written in an easy and entertaining style. It appears to contain an account of all that is known about the œsophagus—its anatomy and deformities ; the methods by which it should be examined ; its functions, both natural and perverted ; and a detailed account of its diseases. Its tone is essentially practical, and the author gives a very lucid and concise idea of his own opinions, as well as mentioning the various alternative theories and methods. At the end of every chapter is a most extensive bibliography, and this feature in itself renders the book very valuable for reference. While it cannot be claimed that there is anything strikingly original in the book, yet it must be appreciated as a most exhaustive account of the present state of knowledge of the œsophagus. In regard to the great problem—the treatment of carcinoma—the author has nothing very encouraging to offer. Radium is mentioned as a possible palliative agent, but all his faith is pinned on excision of the growth. It is suggested that the difficulties presented by operations upon the stomach and colon are strictly comparable with those in the case of

the œsophagus, and that, just as these difficulties have been overcome in the former, so, given "more adequate education and earlier investigation of cases ", they may be overcome in the latter.   We must be pardoned if we assert that Mr. Abel's statement that under these conditions malignant disease of the œsophagus " will be the most favourable type of cancer with which the surgeon has to deal " appears more like·a pious hope than a justifiable conclusion.

Le Cancer primitif du Poumon : Étude anatomo-clinique. By René Huguenin, Ancien Interne lauréat des Hôpitaux de Paris.   Preface by Dr. G. Roussy.   Royal 8vo.   Pp. 330 + iv, illustrated.   1928.   Paris : Masson et Cie.   Fr. 50.

This is a monograph dealing with primary carcinoma of the lung from an anatomical, pathological, and clinical point of view.   The author describes the sites and appearances, macroscopic and microscopic, of the different forms of carcinoma. He describes the course of the disease, the clinical features, the methods of diagnosis, and finally the forms of treatment and the results of radiotherapy. A useful bibliography is attached.

Les Abcès du Poumon. By Michel Léon-Kindberg, Médecin des Hôpitaux de Paris. Crown 8vo. Pp. 134, illustrated. 1928. Paris : Masson et Cie. 1928. Fr. 14.

This is one of the manuals of practical medicine and surgery which are published from time to time by the house of Masson.   The author discusses in a useful and concise manner the etiology, diagnosis, pathology, and treatment of pulmonary abscess.   It is a very useful résumé of the subject, and has a good bibliography.

Le Cancer : Maladie des Cicatrices. By Auguste Lumière, Correspondant de l'Institut ; Correspondant de l'Académie de Médecine. Preface by Professor L. Bérard, Membre Associé de l'Académie de Médecine, etc. 8vo. Pp. 287 + ix. 1929. Paris : Masson et Cie. Fr. 18.

The author gives a comprehensive analysis of the literature on the etiology and treatment of carcinomata, and bases his own theories on the conclusions which he draws.   Tumours are divided into four groups : (1) Inflammatory hyperplasias ; (2) Tumours developed in persistent embryological cell nests ; (3) Tumours of connective tissue ; (4) Malignant epithelial tumours.   It is the fourth group which forms the subject matter of this book.   The author believes that four conditions must be present before a malignant epithelial tumour can develop : (1) Delay in the healing of an injury, and the formation of a cicatrix ; (2) A latent period of about twenty years ; (3) Secondary trauma to the cicatrix to start off the malignant process ; (4) A suitable humoral medium.   This theory is summed up in the phrase of ' no cicatrix, no cancer'.   Doubt is cast upon the value of statistics based on death certificates, and also upon any theory invoking a bacteriological cause of cancer.

The Medical Museum : Modern Developments, Organization. and Technical Methods based on a New System of Visual Teaching. By S. H. Daukes. O.B.E., M.D., D.P.H., Director of the Wellcome Museum of Medical Science, affiliated to the Bureau of Scientific Research. An amplification of a Thesis read for the degree of M.D., Cambridge. 10 in. × 7 in. Pp. 172, illustrated. London : Wellcome Foundation Ltd. Printed for private circulation.

The Wellcome Historical Medical Museum in Wigmore Street, London, W., is known to most medical men ; it is a unique treasure house of specimens and documents which illustrate the history of medicine.   The Wellcome Museum of Medical Science is almost unknown, and yet for medical men it is far more important than the

other, for it seeks to give a graphic representation of the present state of modern medicine. This great addition to the medical institutions of London has grown up so quietly just off the bustle of Euston Road that its existence has almost escaped notice. The book which its curator, Dr. S. H. Daukes, has written about it is thus most opportune.

There is no doubt about it that in the opinion of most practitioners the museums attached to medical schools have outlived their period of usefulness and might well be scrapped. This opinion is also shared by many teachers, particularly those who have to do with the experimental branches of medicine. There is something wrong with medical museums, and the question which many are asking is : How can they be made alive ? Dr. Daukes has not only asked this question ; he has answered it by bringing into being—through the unstinted generosity of Dr. Henry Wellcome —a great medical museum of a new kind and based on novel lines. Dr. Daukes holds the opinion that pathological specimens can serve a useful purpose in medical education only when they are given their proper setting. They must not be separated from the picture of the patient and his disease. Take a case of endocarditis ; the heart with the aortic valves studded with vegetations is shown, but with it is given the photograph of the sick boy from whose body the specimen came. The temperature chart and pulse-rate are shown beside the patient. A graphic picture of the heart symptoms is set beside the chart. With the case is placed the boy's tibia— the site of an acute osteomyelitis. Cultures of organisms grown from the tibia and blood form part of the exhibit. In brief, Dr. Daukes's aim is to make the medical museum the central department of a medical school where all branches of knowledge are made to focus their combined efforts to unravel the nature of a disease, exemplify its symptoms, give the means of diagnosis, set forth graphically the modes of treatment, and, where possible, illustrate the methods of prevention. Some diseases lend · themselves to this graphic method of illustration better than others. Tuberculosis and syphilis may be taken as examples. Both these diseases are fully illustrated in the new museum by means of photographs, drawings, models, and actual specimens ; the modes of infection, the infective organisms, their isolation and identification ; the symptoms, diagnosis, treatment, and prevention are all portrayed. The visitor, be he layman, medical student, or medical practitioner, has set before him a graphic representation of all that is known concerning these particular diseases. The whole field of human disease is brought within the scope of this new museum.

The merits of such a system are obvious ; but we must not forget that its attainment is difficult and costly. Not everyone has the resource and happy ingenuity of Dr. Daukes in designing the means which will bring before the student the full story of a disease told graphically ; only institutions which can command artists, modellers, and technicians are in a position to undertake such a scheme. Medicine is progressive ; every day sees an addition to knowledge, and the exhibits have to alter as knowledge grows. There has to be a continuous struggle to keep up to date ; there have to be repeated periods of scrapping ; there must be almost unlimited space for exhibition, and apparatus of the most costly kind. There must be a most liberal supply of expensive cases and of exhibition stands. Labels have to be changed or improved. Literature has to be surveyed and abstracted month by month ; a great and efficient staff has to be maintained. Granted all these conditions, with an inventive and resourceful brain behind all, such a desirable national institution as the Wellcome Museum of Medical Science becomes possible. Such a museum is a great engine of medical education, and represents medical propaganda of the best kind. Clearly, to carry out such a scheme in its complete form is beyond the financial resources of most medical schools ; but without a doubt it is an ideal which every school should aim at.

Dr. Daukes is also alive to another function of museums beyond that of educating medical students. They are also institutions which have to do—or should have to do—with the increase of knowledge. They should cater not only for the needs of students proceeding to examination, and the needs of men in practice, but also for the needs of men who are engaged on research. For research the graphic illustration of current knowledge is useless ; only original documents—the actual specimens—

are of value. The research museum and the teaching museum have to serve different purposes and must be organized on separate lines. That is no reason why our larger museums should not aim at serving both purposes, but it would be a misfortune if the possibilities of museums as powerful instruments of research were lost sight of.

Dr. Daukes's book, excellently printed, gives a history of the Museum he has done so much to create. It does more : it supplies curators of medical museums with much technical information for which they will be grateful.

A Surgical Diagnosis. By J. L. DONHAUSER, A.B., M.D., F.A.C.S., Clinical Professor of Surgery, Albany Medical College (Union University). Royal 8vo. Pp. 799 + xxvii, illustrated. 1929. New York and London : D. Appleton & Co. 42s. net.

THE purpose of this book is to set forth systematically and in great detail the methods—history-taking, clinical examination, and laboratory and radiological data—whereby a diagnosis may be established in the surgical conditions affecting all parts of the body. It is based on nearly twenty years' experience in the teaching of surgical diagnosis, and is intended primarily for students, but also for house officers and general practitioners. It is a very thorough and comprehensive work, the compilation of which has entailed much labour. It is a monumental example of one method of clinical teaching, the 'list' method, which appeals to some, but certainly not to all intellects. The student who sets out to learn clinical surgery by preparing lists of all the possible diseases of every individual organ will revel in this book to his heart's content, for these lists are irreproachable in their completeness. Their appalling length will, however, fill with dismay a mind not so pigeonholed ; and they will leave unmoved the student who is pinning his faith to an underlying uniformity in pathology in all organs, modified here and there by the anatomical or physiological peculiarities of the affected part.

The contents are divided up into twenty-four sections, ten of which deal with abdominal surgery, four with conditions affecting the extremities, and the remainder with diseases of the head, neck, thorax, urogenital system, the general consideration of the examination of patients, the infections, and the tumours. In each section a complete list of all the diseases affecting that part is given, and in the following pages a few paragraphs are devoted to each disease in turn, with a brief description of the salient features differentiating it from the others. At the end of most of the sections there is a large table of differential diagnosis. Most of these tables are too cumbersome and complicated to be instructive. One feels that the object of the author has been to leave nothing out, and one fears that his success renders the book too burdensome for the average student. Except for those capable of incredible feats of memory, it is more likely to be of value as a book of reference than as a text-book.

Medical Adventure : Some Experiences of a General Practitioner. By Dr. ERNEST WARD, M.D. (Cantab.), F.R.C.S. Crown 8vo. Pp. 291, with 10 illustrations and a portrait of the Author. 1929. London : John Bale, Sons & Danielsson, Ltd. 8s. 6d. net.

THE present volume deserves a warm welcome from all medical readers. It represents a much more serious contribution to medical literature than is implied by its title. Many of the chapters are articles written for the *London Hospital Gazette* to bring before students the realities of general practice. The great value of the articles consists in the fact that they are the outcome of real experience, and that the problems are viewed from the point of the man in family practice. Chiefly they deal with commonplace diseases—for example, measles or mumps—and there is a preponderating number of chapters on skin diseases, both rare and common. The few chapters on surgical subjects are all full of acute observation and are illuminated by great humour. As an example of this, in the chapter on carcinoma of the rectum we are told of a case of apparently hopeless ulcerating growth of the bowel

which was cured by anti-specific remedies. The patient celebrated his recovery from imminent death by attending no fewer than three 'revival meetings' in one day. We wish that Dr. Ward would give us further articles dealing with the diagnosis, treatment, and results of surgical conditions, as seen by the family doctor.

Catalogue of Lewis's Medical and Scientific Circulating Library. Part I, Authors and Titles. Part II, Classified Index of Subjects, with Names of Authors who have written upon them. Revised to the end of 1927. Demy 8vo. Pp. 576. 1929. London : H. K. Lewis & Co. Ltd. 15s. net. (To Subscribers 7s. 6d. net.)

MESSRS. LEWIS have carried out a work of great value and importance in the foundation of their circulating medical library. By this means many an isolated practitioner has been able to get at otherwise inaccessible books, and also the smaller medical libraries can greatly enlarge the scope of their usefulness by affiliation with this organization. The present catalogue is not only a list of all the books available, but is accompanied by an index showing which books are available on any particular subject, and the author's name and date of publication. This catalogue and index greatly enhance the value of Lewis's library.

Guy's Hospital Reports. Edited by ARTHUR F. HURST, M.D. Vol. LXXIX (Vol IX, Fourth Series), No. 1, January, 1929. Medium 8vo. Pp. 126, illustrated. 1929. London : Lancet Ltd. 12s. 6d. net.

AMONGST other articles this number contains : " Notes on the Etiology of Appendicitis ", by W. H. Bowen, in which the author concludes that the main etiological factor in appendicitis is stagnation in the appendix ; " Hydatid Cyst of the Kidney ", by R. P. Rowlands ; and " Visualization of Bile-ducts after an Opaque Meal ", by J. F. Venables.

Report on Fourth International Congress of Military Medicine and Pharmacy, Warsaw, Poland, May–June, 1927. By COMMANDER W. SEAMAN BAINBRIDGE, C-F., United States Naval Reserve ; Member of Permanent Committee. Demy 8vo. Pp. 248 + ix, illustrated. 1927. Wisconsin : The Collegiate Press.

THIS report has been compiled, presumably for the American Government, by a member of the Permanent Committee. It is difficult to assess the status of an International Congress to which France sent over 70 delegates, Great Britain 7, and the United States 5.

It is clear that subjects of fundamental interest in military medicine were under discussion, including the evacuation of wounded, head injuries with all their complications and sequelæ, and the therapeutics of the arsenobenzols. Apart from the immense range of these different subjects, it is difficult to assess the value of the conclusions of the Congress, because no one of the British delegates can boast of large clinical experience of the subjects under discussion.

It would seem that the vision of Belgium, who called the first Congress in 1921, has been amply justified, but if the delegates at these Congresses are granted opportunities of self-education in the care of the sick and wounded, it is not easy to understand why the representatives from Great Britain are limited solely to regular members of the three services.

Reflections and Operations. By Sir JOHN O'CONOR, K.B.E., M.A., M.D. (Dublin), late Senior Medical Officer, British Hospital, Buenos Aires. Edited by BEATRICE and MAY O'CONOR, with a Foreword by HERBERT J. PATERSON, C.B.E., M.C., M.D. (Cantab.), F.R.C.S., Senior Surgeon, London Temperance Hospital. Demy 8vo. Pp. 361 + xxxvi, with 4 plates. 1929. London : Baillière, Tindall & Cox. 21s. net.

OVER twenty-five years ago the reviewer, like many others, was attracted by the writings of O'Conor, of Buenos Aires, and now welcomes the collection of his numerous published papers in one volume. O'Conor left England for the Argentine

in 1889 as doctor to a mining company, on the failure of which he was appointed House Surgeon to the British Hospital in Buenos Aires, soon becoming its Senior Medical Officer—a position he retained until his death.

Few young surgeons can have had such unrivalled opportunities of major surgery, and O'Conor soon proved his worthiness to be entrusted therewith. He was a 'general' surgeon in the widest sense of the term, and his writings, covering practically the whole field of surgery, display marked originality, extraordinary breadth of view, clear thinking, concise description, sound common- : ˙ .ˈ   ˙ ' f:arless criticism, and hatred of all shams. His great practical ‚·· ·   .   , his unusually dogmatic style in teaching, and everywhere his writings abound in most useful practical hints and 'tips'. Many of his views run counter to those usually regarded as orthodox—for example, his preference for anterior rather than posterior gastro-enterostomy, his rule "never to quit the abdomen in acute appendicitis without removing the appendix", his strictures upon the use of early massage and movement in the treatment of fractures, and his spirited defence of Whitehead's operation for hæmorrhoids. Moreover, his advocacy of alcohol both as an article of diet and in the treatment of disease would not be approved by our numerous temperance associations. No one can fail to enjoy and to be encouraged by a perusal of this volume, and to be the better for the introspective self-criticism it must spontaneously evoke.

EPOCH-MAKING BOOKS IN BRITISH SURGERY.

By Sir D'ARCY POWER, K.B.E., London.

XI. "MY BOOK" BY JOHN ABERNETHY.

John Abernethy was the first of the great English surgeons of the last century to treat his patients by expectant means rather than ·by operation. He thus founded a school of British surgery based upon physiology rather than anatomy. The idea was fundamentally sound, but Abernethy was a pioneer, and as we now read his works it is easy to see how extraordinarily inadequate was the foundation upon which he built. He had no knowledge of physiology in the modern sense ; his pathology was crude ; he was ignorant of the part played by micro-organisms in disease ; and when syphilis was rife he did not recognize either its later lesions, which we now call tertiary, or its hereditariness. Yet by sheer genius his conclusions are often correct, and later surgeons accepted the basis though they modified the teaching.

Abernethy put forward his theories in a book which he always spoke of as " My Book ". It was rarely out of his thoughts. He spoke of it to his pupils, he dragged it into every lecture, he presented it to his patients. His classes were large and his patients many, so that " My Book " became one of the best-known works in the early part of the nineteenth century, and it was known officially as a treatise " On the constitutional origin and treatment of Local Diseases ". It first appeared in 1806 under the title of " Surgical Observations, Part the second, containing an account of the disorders of the health in general and of the Digestive Organs in particular which accompany local diseases and obstruct their cure ". The 2nd edition appeared in 1811, the 3rd in 1814, the 4th in 1817, the 5th in 1820, the 6th in 1822, the 7th in 1824, the 8th in 1826, the 9th in 1827, the 10th in 1827, the 11th in 1829, and Abernethy died in 1831.

The main thesis advanced by Abernethy was that errors of digestion were the *fons et origo* of many surgical disorders and that diet, gentle purging, and an open-air life would cure many of the conditions generally met with in surgical practice. This was probably true, for during the life of Abernethy the well-to-do habitually over-ate themselves, took but little exercise, drank a

great deal, and were usually constipated; whilst the poor were disgracefully housed, were indigent beyond conception, and were for the most part drunken. Neither rich nor poor were aware of the value of fresh air. He says :—

" Nothing in Pathology is more generally admitted than the reciprocal operation of disorders of the head and of the digestive organs on each other; yet the exceptions to this general rule deserve to be remarked in a comprehensive examination of the subject. Some persons have great disorder of the digestive organs without any apparent affection of the nervous system; and even diseases of a fatal nature may take place in the former organs without affecting the latter. Indeed if we examine any of the most evidently sympathetic affections we shall find the same exceptions. The stomach generally sympathizes with disorder of the uterus but it does not invariably do so.

" Many of the symptoms recorded in the description of the state of health of those persons who are affected by disorder in the digestive organs denote a disturbance of the nervous and muscular powers. When we observe this compound disorder we can seldom determine which were the primarily affected organs. The history will generally show that the derangement of the digestive organs is secondary. When it arises from local irritation, it can be produced only through the medium of the sensorium. When it is idiopathic it frequently originates in causes which affect the nervous system primarily, such as anxiety, too great exertion of mind or body and impure air. Sedentary habits and irregularities of diet are causes which may be supposed to act locally on the digestive organs themselves. Nervous irritability and weakness are not perhaps susceptible of a direct cure by medicine; but the disorders of the digestive organs are more corrigible by medical remedies. In practice these require our chief attention, and if their disorders be corrected all nervous irritation frequently ceases and health is restored. In many instances the nervous irritation which has induced the disease is trivial and would soon cease were it not kept up by the reaction of its effects.

" Whether this disorder of the digestive organs be primary or secondary it generally produces irritation in the brain; and thus may cause in many instances actual disease of that organ. The connection of local disease with general disorder has often been remarked; it has formerly been attributed to impurity of the fluids; a theory which is not irrational. Imperfect digestion must influence the qualities of the blood and all parts of the body may be affected from this source. But in accounting for the reciprocal influence of disorders of the head and the digestive organs on each other, the modern explanation of these phenomena by means of sympathies is perhaps preferable. Afflicting intelligence will destroy the appetite and produce a white tongue in a healthy person; a blow on the stomach disorders the head. These phenomena take place independently of the blood and can only be explained by admitting that disturbance of one organ immediately affects the other."

There is no doubt that Abernethy rode his hobby too hard, but he drew attention to the influence which the general health exercises over local conditions, and thus in some vague way seems to have foreshadowed the doctrine of immunity. He says about treatment :—

" I do not feel altogether competent to give full directions relative to this subject because I have never attended to medical cases with that degree

of observation which would lead me properly to appreciate the efficacy of different medicines when administered either in their simple or compounded forms." He gives, however, some simple rules as to diet, saying about food: " First, with respect to quantity. There can be no advantage in putting more food into the stomach than it is competent to digest, for the surplus can never afford nourishment to the body; on the contrary, it will be productive of various ills. Being in a warm and moist place the undigested food will undergo those chemical changes natural to dead vegetable and animal matter, the vegetable food will ferment and become acid, the animal will grow rancid and putrid. . . . Nature seems to have formed animals to live and enjoy health upon a scanty and precarious supply of food; but man, in civilized society, having food always at command and finding gratification from its taste and a temporary hilarity and energy result from the excitement of his stomach, which he can at pleasure produce, eats and drinks an enormous deal more than is necessary for his wants or welfare. He fills his stomach and bowels with food which actually putrefies in those organs. He fills, also, his bloodvessels till he oppresses them and induces diseases in them as well as in his heart. . . . In proportion as the powers of the stomach are weak so ought we to diminish the quantity of our food and take care that it should be as nutritive and easy of digestion as possible.

" Secondly, as to quality; It is not my intention to discuss the question as to the nature of the food proper to mankind but I may observe that its qualities should be adapted to the feelings of the stomach. In proof of this numerous instances might be mentioned of apparently unfit substances agreeing with the stomach, being digested and even quieting an irritable state of the stomach merely because they were suitable to its feeling. Instances might also be mentioned of changes in diet producing a tranquil and healthy state of stomach in cases where medicines had been tried in vain.

" Thirdly, as to the times of taking food. It is evidently the intention of nature that we should put into the stomach a certain portion of food, the excitement of which inducing a secretion of gastric fluid by its action becomes digested. This office of the stomach being effected it should be left in a state of repose till its powers are restored and accumulated, and this return of energy would, in a state of health, be denoted by a return of appetite. It is therefore reasonable to allot the same portion of time for the same purpose when the organ is disordered whilst we have diminished the quantity of our food in order to proportion it to the diminished powers of the organ; yet instead of pursuing this rational plan of diet many persons are taking food every third or fourth hour pleading in excuse for such conduct that they cannot do without it. The truth is, that when the stomach is disordered the exertion of digesting a single meal after its excitement and efforts have ceased is productive of sensations of languor, sinking and inquietude which ought to be calmed or counteracted by medicines and not by food, for a second meal cannot be digested in this state of the stomach. We also often tease and disorder our stomachs by fasting for too long a period; and when we have thus brought on what I may call a discontented state of the organ, unfitting it for its office we sit to a meal and fill it to its utmost, regardless of its powers or its feelings. The rules, then, for diet may be thus summarily expressed; We

should proportion the quantity of food to the powers of the stomach, adapt its quality to the feelings of the organ, take it at regular intervals of six or seven hours thrice during the day."

Abernethy's advice in regard to alcohol could not have proved very palatable to a generation somewhat addicted to its immoderate use. He says : " All stimulants must be regarded as medicines ; vinous liquors are of this class and being very suitable to the feelings of the stomach are in many cases very useful. The rule for taking vinous liquors in persons to whom habit has rendered them necessary may be thus briefly stated. They should not take them during their meals lest the temporary excitement they produce should induce them to take more food than the powers of the stomach are capable of digesting but afterwards they may be allowed so much of them as may be required to induce agreeable feelings ; or to express the fact more clearly, as is necessary to prevent those uncomfortable sensations which the want of them may occasion ; and, it may be added, the less they take the better."

ENTEROCYSTOMA.

By RUTH ELIZABETH MILLAR, DUNFERMLINE;

AND GEORGE ROBERTSON,

HON. SURGEON TO THE DUNFERMLINE AND WEST OF FIFE HOSPITAL.

ENTEROCYSTOMATA are sufficiently rare to warrant a description of the rarest type of these peculiar and etiologically uncertain tumours. We recently operated on such a case in the Dunfermline and West of Fife Hospital, the patient being sent by one of our colleagues.

HISTORY.—J. F., a female, age 8 years, the youngest of a family of three, was a healthy child at birth and maintained good health until she reached the age of 4 years, when she began to complain of attacks of sickness accompanied by severe vomiting. Her mother states that each attack lasted twenty-four hours, had a sudden onset and an equally sudden termination, that the child was prostrated during the attacks, and that the vomit was only exceptionally bile-stained. At first the interval between attacks was two to three months, but later was reduced to one month, so that a periodicity suspiciously like that of the menses was established. Her mother actually imagined that even at this early age the little girl was suffering from a precocious development of the sexual glands. Thus she reached the age of 7 years, which was followed by such complete freedom from symptoms for a period of six months that it was thought her troubles had at last come to an end. Four months ago, however, the attacks returned with increased severity and frequency; severe vomiting, frequently bile-stained, and preceded and accompanied by pain in the right iliac fossa and epigastrium, continued for twenty-four hours with each attack. The intervals of freedom had shortened to two weeks. Within the last month a weekly attack has occurred. Right iliac pain had become so prominent a feature that she was sent to hospital for operation, with the diagnosis of appendicitis. We, having no opportunity to observe an attack and considering the diagnosis probably correct, operated.

OPERATION.—Operation, as for appendicectomy, was performed on May 4, 1929. Immediately the abdominal cavity was opened an abnormality was detected. An elongated, tense, cystic tumour was found superimposed upon the cæcum, the long axes of tumour and intestine being parallel (*Fig.* 190). The sausage-shaped mass possessed a typically intestinal appearance, exhibited peristalsis, and a constriction existed near its middle. Both ends were blind ; that which pointed to the hepatic flexure was the larger and more bulbous, the other, little more than half the size, pointed downwards and slightly inwards and overlaid the vermiform appendix, which was normal. On its deep aspect, two-thirds of the tumour, measured from the smaller end, was connected by a mesentery to the true mesentery of the ileocæcal angle.
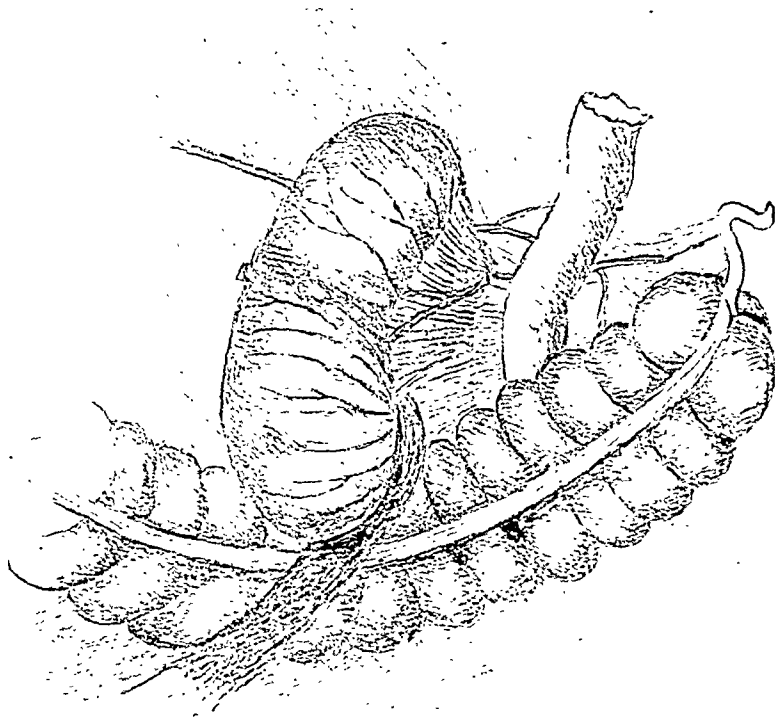
Fig. 191.—The cystoma rotated previous to removal: its attachments, mesentery and band, are well seen.
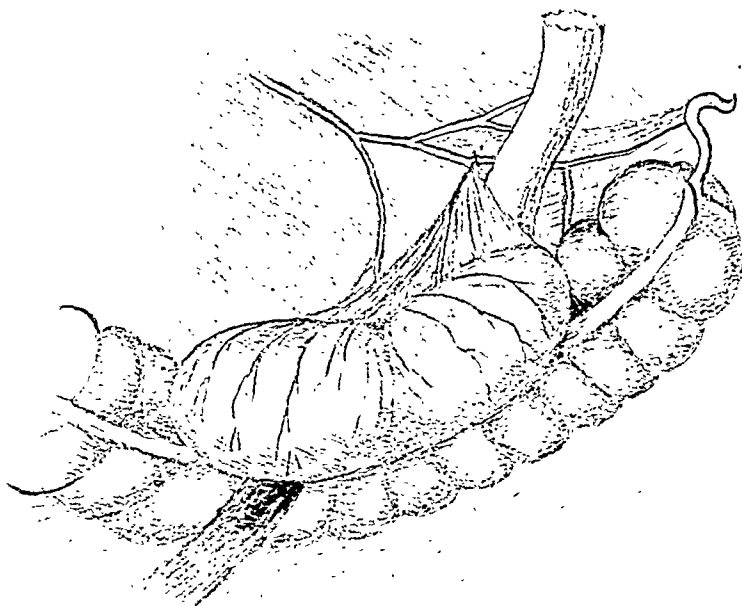
Fig. 190.—The appearances presented on opening the abdomen.

The inferior aspect of the larger bulbous end was less loosely attached by an apparently adventitious band to a pericolic membrane enclosing the ascending colon and blending on the lateral aspect of the gut with the parietal peritoneum. The loose pedicle allowed a fairly easy delivery of the cyst through the operation incision. The chief blood-supply of the tumour was directed to its mesenteric half from the ileocolic vessels, while in the adventitious band only capillaries existed, so that mass ligation was necessary only for the true mesentery of the cyst. A few tiny bleeding points were ligated over the colon when the tumour had been separated and removed. The cyst removed, no other abdominal abnormality could be seen. The appendix was resected and the wound closed.

After the patient had been removed from the operation room we inspected the cyst. As it lay on a cold specimen tray it showed active peristalsis, that wave being more pronounced which began at the small end and spread to the other, though the reverse wave was not inconsiderable. Light slapping

FIG. 192.—Cystoma after removal. (*Natural size.*)

of the cyst with a wet swab was at once followed by increased peristaltic movement, while the application of warm moist gauze pads excited the most vigorous peristalsis of all. These contractions ceased only after a lapse of over two hours, when repeated attempts, mechanical and thermal, failed to induce a response.

Figs. 190 and 191 were drawn immediately after operation. The general appearance suggests a piece of intestine, and, as will be seen from *Fig.* 192, two tiny appendices epiploicæ are situated in the sulcus on the lateral aspect of the tumour as it lay in the abdomen. Its length is 11 cm., the maximum girth at the bulbous end 10 cm., the mesenteric line of attachment is 10 cm., and the maximum length of pedicle 4 cm. Careful examination of the cyst by ourselves revealed no evidence of scar at either end of the cyst. We could therefore only hazard an opinion as to its possible origin. Two fluid ounces of an almost perfectly transparent viscous mucoid fluid constituted the content of the cyst, which was unilocular.

PATHOLOGICAL REPORT.—The Royal College of Physicians' Laboratory, Edinburgh, reported on the tumour as follows :—

Fluid Content.—Reaction, neutral ; urea, 0·05 per cent ; total protein, 0·15 per cent ; stained and unstained films show catarrhal cells and polymorphs, no food débris seen.

FIG. 193.—Shows atrophic mucous membrane (reticular epithelial cells), with fragmentary gland elements (goblet cells). Well-marked muscularis mucosæ. (× 75.)

FIG. 194.—Shows submucous layer of considerable extent. Two isolated lymphoid follicles are seen on the lumen surface. (× 7·5.)
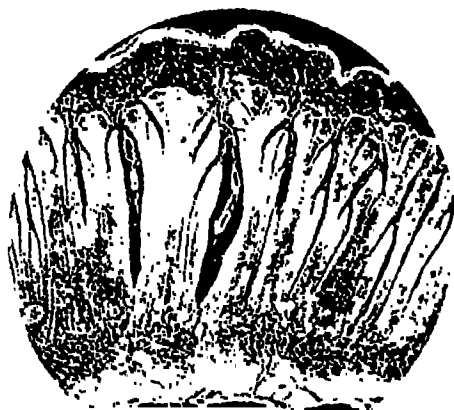
FIG. 195.—Shows very great hypertrophy of the circular and longitudinal muscular coats. (× 7·5.)

FIG. 196.—Shows a lymph gland in the mesentery of the tumour, also blood-vessels and nerve-fibres. (× 75.)

Specimen.—This has all the appearances of a portion of intestine. It is more dilated at one end than at the other and there is some evidence of slight constriction between these two portions. At the broad dilated end there is a rim of what might have been scar tissue, but the appearance is not that of scar when cut

across. A ridge, corresponding doubtless to the mesenteric attachment, runs along the specimen in its long axis and outer aspect. Three portions were taken for microscopic examination, one from either end and one through the mesenteric attachment. Microscopically there is no evidence of cicatricial tissue at either end. The chief features are : (1) An atrophic mucous membrane almost devoid of epithelial covering ; (2) A greatly hypertrophied muscle coat.

In more detail the microscopic characters are : The mucous membrane shows a condensation of cells which has much the appearance of an epithelial covering, but which consists really of reticular epithelioid (connective-tissue) cells, forming a smooth surface layer. Here and there are gland elements of fragmentary character. In their appearance (numerous goblet cells in some cases) they suggest those of large intestine. Small isolated lymphoid follicles are present and extend right to the lumen surface. The cells of this mucous membrane are of reticulum type, connective-tissue cells, lymphoid cells, and eosinophils. A well-marked muscularis mucosæ of two layers, superficial circular and deeper longitudinal, is present (*Fig.* 193). The submucous layer of loose connective tissue, with numerous blood-vessels, is of considerable extent and is separated from the muscular layer by a very condensed fibrous tissue (*Fig.* 194). The circular and longitudinal muscular coats are markedly hypertrophied. (*Fig.* 195). In the mesentery there are well-formed blood-vessels, numerous nerve-fibres, and a small lymphatic gland (*Fig.* 196).

In our opinion the tumour undoubtedly belongs to the enterocystomata, which have been described by Roth,[1] Dittrich, Runkel, Rembach, Gfeller, Colmers, Terrier and Lecène,[2] Cautley,[3] and others. It would appear that Roth's studies were confined to enterocystomata of vitelline origin. He describes them as " congenital pouches filled with fluid whose wall possesses more or less perfectly the structure of the intestinal canal ". In enterocystomata of vitelline origin it is only that part of the omphalo-mesenteric duct attached to the intestine which persists, and, becoming cystic, may either still preserve its communication with the lumen of the gut or become completely separated from it. Most authors agree that all enterocystomata cannot be proved to be of vitelline origin, and some hold that certain non-vitelline cysts are teratoid in character. To say that a cyst is non-vitelline because it has developed on the mesenteric border of the intestine or between the leaves of the mesentery would be quite incorrect, for, according to many observers; these are frequent sites, though the antimesenteric border may be the most usual. Again, though the structure is typically that of the small intestine in most cases of vitelline cysts, it would be wrong to assign too much importance to variations in single features, e.g., the mucosa, for it must be remembered that the origin of the cyst dates back to embryonic life when the intestinal epithelium was incompletely differentiated ; thus epithelial polymorphism is easily explained. The rarest type of enterocystoma is that we instance, in which the cyst and normal intestine are connected only by a peritoneal fold or mesentery, no solid or patent intestinal pedicle existing between them. Whatever their origin, all enterocystomata would seem to have certain points in common : viz., etiologically, that they are mostly found in young females ; pathologically, that they are most commonly found in the region of the terminal ileum or in the ileocæcal angle, are unilocular, and filled with a clear, viscous, mucoid liquid. Malignant disease (spindle-celled sarcoma) has been known to invade the cyst wall. and one case is reported where it became infected by tubercle from contact with a loop of tuberculous gut.

Clinical History.—These tumours may be symptomless throughout life ; some have been accidentally discovered at autopsy. Symptoms, when present, are vague abdominal pain and recurrent attacks of vomiting. Occasionally they cause intestinal obstruction by torsion or by seriously encroaching upon the lumen of the gut (submucous type). They may, occasionally, be palpated as a rounded or elongated tumour. When they have shown malignancy they have been known to cause persistent ascites. A diagnosis is difficult. Symptoms of intestinal obstruction may fill the picture ; at other times appendicitis, acute or catarrhal, may be diagnosed. Only laparotomy can disclose the real nature of the disease.

Treatment.—In uncomplicated cases the treatment consists of extirpation, which may or may not necessitate resection of a piece of intestine. When the cyst is entirely separated from the bowel and has a mesenteric pedicle, its removal is a very simple surgical procedure, as in our case.

The case we present possesses many features common to the etiology, pathological anatomy, and clinical behaviour of those cysts which have been reported by other surgeons, but we are uncertain whether it is of vitelline origin or not.

Pain and Vomiting—Disturbed Reflexes.—We have renewed our interest *in the interpretation of the disturbed reflexes of acute abdominal diseases.* Referring back to the patient's history we find that all attacks she suffered from the age of 4 to 8 years were marked by severe vomiting, but that *only* within the last six months had abdominal pain appeared as a symptom and, becoming more severe with each succeeding attack, demanded special treatment, as on the last three or four occasions.

Pain originating in the hollow viscera is of great and abiding interest. It seems to us that, though it is generally believed that the pain of intestinal colic, appendicular colic, etc., is due to severe and prolonged contraction of the plain muscle of the viscus, confusion results in the minds of many who persistently, and with no supporting evidence at all, forsake this definite and proved cause of visceral pain just because a lesion, e.g., an ulcer, happens to be present.

In the enterocystoma under review pain preceded and accompanied the attacks only in the last six months, *though painless attacks of severe vomiting* had occurred with great regularity for the previous three and a half years. It will be noted from the microphotographs that a great hypertrophy of the muscle coat existed, while the mucous membrane showed a definite atrophy. Both these features were probably progressive. Atrophy of the mucous membrane would result in a reduced power to *secrete* and most probably to absorb ; muscular hypertrophy would *increase* peristalsis and cause pain.

We have found that a patient who possesses *what we term the 'sausage'* appendix, i.e., an appendix whose muscular coat is greatly hypertrophied and whose lumen is dilated behind a stricture near the cæcal end of the viscus, suffers much from gastric symptoms, the so-called 'appendix dyspepsia' which, when actual obstruction of the abnormal viscus threatens, amounts to actual and repeated attacks of vomiting. We have been so impressed with our constant operative findings, that if a patient suffering from an acute lesion of the appendix tells us that he or she has vomited repeatedly on the

first day of the disease, we feel confident that on opening the abdomen the 'sausage' appendix will be found. When the appendicular wall becomes gangrenous pain lessens or disappears; this is not because a dead appendix, like a dead foot, causes no pain, as Murphy used to teach; rather is it because the muscle of the appendix has lost its contractility.

In our enterocystoma progressive hypertrophy of the muscle coat had occurred over a period of four years, and thus we seek to explain the increasing severity of the attacks, which, though at first only evidenced by reflex vomiting, were at the later period painful as well. It is perhaps admissible to believe that temporary strong peristalsis of our patient's intestinal tube might be shared by the cystoma, an isolated intestinal segment whose nerve-supply was similar to and connected with that of the normal intestine. A heavy meal, a common error in a child's dietary, might not produce actual colic in the normal gut, but might easily do so in a closed segment whose cavity was distended with fluid and whose wall possessed great muscular hypertrophy. The intervals between the attacks, when no complaints of any kind were made by the young girl, are more difficult to explain than the attacks themselves. The intervals of freedom from abdominal distress that accompany catarrhal appendicitis are explained by the re-establishment of free drainage of appendicular contents into the cæcum. In our case, however, the only diminution of content that could occur would be by absorption via the blood-vessels and lymphatics of the anomalous intestinal wall. Tension of the cyst from increase of content would excite an attack (vomiting and pain) by supplying the stimulus to the hypertrophied muscular coat; relaxation of the cyst wall would act in an opposite manner. The mucous membrane of the cyst was, no doubt, though atrophied and atypical, still to some extent secretory and absorptive; but exactly what stimulated secretion on the one hand, inducing an attack, and absorption on the other, terminating one, it is, in our opinion, impossible to say. Even partial torsion of the whole cystoma is untenable as a cause of the attacks, for we found that the nature of its attachment to the colon and parietal peritoneum laterally would preclude all attempts at torsion. Moreover, the wall and contents of the cyst gave no evidence of either past or recent interference with the blood-supply.

We are indebted to Dr. Harvey, of the Royal College of Physicians Laboratory, Edinburgh, for his report on the specimen and for the microscopic slides. To Mr. Macgregor, our artist friend, we tender our thanks for the drawings.

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[4] Robertson, G., " Disturbed Reflexes: their Significance in Acute Abdominal Diseases ", *Surg. Gynecol. and Obst.*, 1926, Dec., 806.

CONGENITAL DISLOCATION OF THE HIP: WITH SPECIAL REFERENCE TO THE ANATOMY.

(Being the Lady Jones Lecture delivered at the University of Liverpool on Feb. 28, 1929.)

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ALTHOUGH congenital dislocation of the hip is not nearly so common in this country as it is in certain parts of France and Italy, we meet it here sufficiently often to make it a subject both of interest and importance. In spite of the fact that for many years past an increasing amount of attention has been paid to this deformity by surgeons throughout the world, there is still no general agreement as to the treatment, which must necessarily vary with the age of the patient. A great deal can be found in medical literature about the anatomy of this affection, but there are details which appear to have been overlooked, and others, I venture to think, which have not received the attention they seem to deserve. This paper is a review of the subject from the anatomical aspect, and then discusses the bearing that the facts presented have on the treatment.

ANATOMY OF THE NORMAL HIP.

To turn for a moment to the normal anatomy of the hip-joint : if the neck of the adult femur is looked at from the front, there is often apparent a faint ridge, more marked above than below; this divides the surface into an inner rough and an outer smooth area, the latter being grooved. Walmsley[1] named this ridge 'the capsular ridge', and compared the groove external to it with a pulley, and called it 'the capsular groove'. In contact with this groove is the supero-lateral portion of the capsule, which is under greatest tension, he says, in full extension of the joint.

The angle formed by the axis of the head and neck with that of the shaft—the 'angle of inclination', as it is called—is about 125°, or slightly more in children, but it may vary considerably in apparently normal hips. The angle of anteversion, or antetorsion, which is the angle the axis of the neck makes with the transcondylar line, shows even greater variation in hips which display no sign of instability. Pearson[2] gives the mean figure for this angle as 15·3°, while Burghard[3] says it varies from 15° to 25°. Soutter and Bradford[4], in 154 normal femora, found the angle varied from 37° to −25°. with an average of 14·3°. Mikulicz[5] gives the average figure as 11·6°, while Durham,[6] in 200 femora, found the angle varied from 0° to 35°. with an average of 11·9°. He argued that anything up to 35°, even in a dislocated hip, might be disregarded.

Of the muscles, the only group I need mention consists of the two obturators, the gemelli, and the quadratus. which pass practically horizontally

outwards to the femur. Besides their obvious use as external rotators, it seems highly probable that they serve a useful purpose in keeping the head of the femur pressed home in its socket.

ANATOMY OF THE DISLOCATED HIP.

With these few remarks I pass to the consideration of the modifications of the normal anatomy met with in the presence of a congenital dislocation of the head of the femur. The statements I venture to make are founded on a study of 35 museum specimens, comprising 46 dislocated hips; an experience of some 50 open operations on cases of this deformity (in 26 of which the joint was opened); and a perusal of much of the extensive literature in which are found many observations on the anatomy. The scarcity of museum specimens of young subjects is to some extent compensated for by the fact that research on the living is largely confined to the young.

THE BONES.

The Os Innominatum.— We may begin with the os innominatum, since the source of all the trouble undoubtedly lies in the acetabulum. If a fœtal specimen be examined, the most striking, and often the only, feature besides the slight displacement of the head of the femur is the poor development of the upper margin of the acetabulum (*Fig.* 197). This is the primary fault, to which all the other changes are secondary. Slight laxity of the capsule

FIG. 197.—Fœtus of 5½ months. Note rounded postero-superior margin of acetabulum with extension of joint behind as well as above this. (*After Van Neck.*)

FIG. 198.   Note obliteration of acetabulum by overgrowth of ischium, which forms a tubercle on each side.   (Musée Dupuytren 742.)
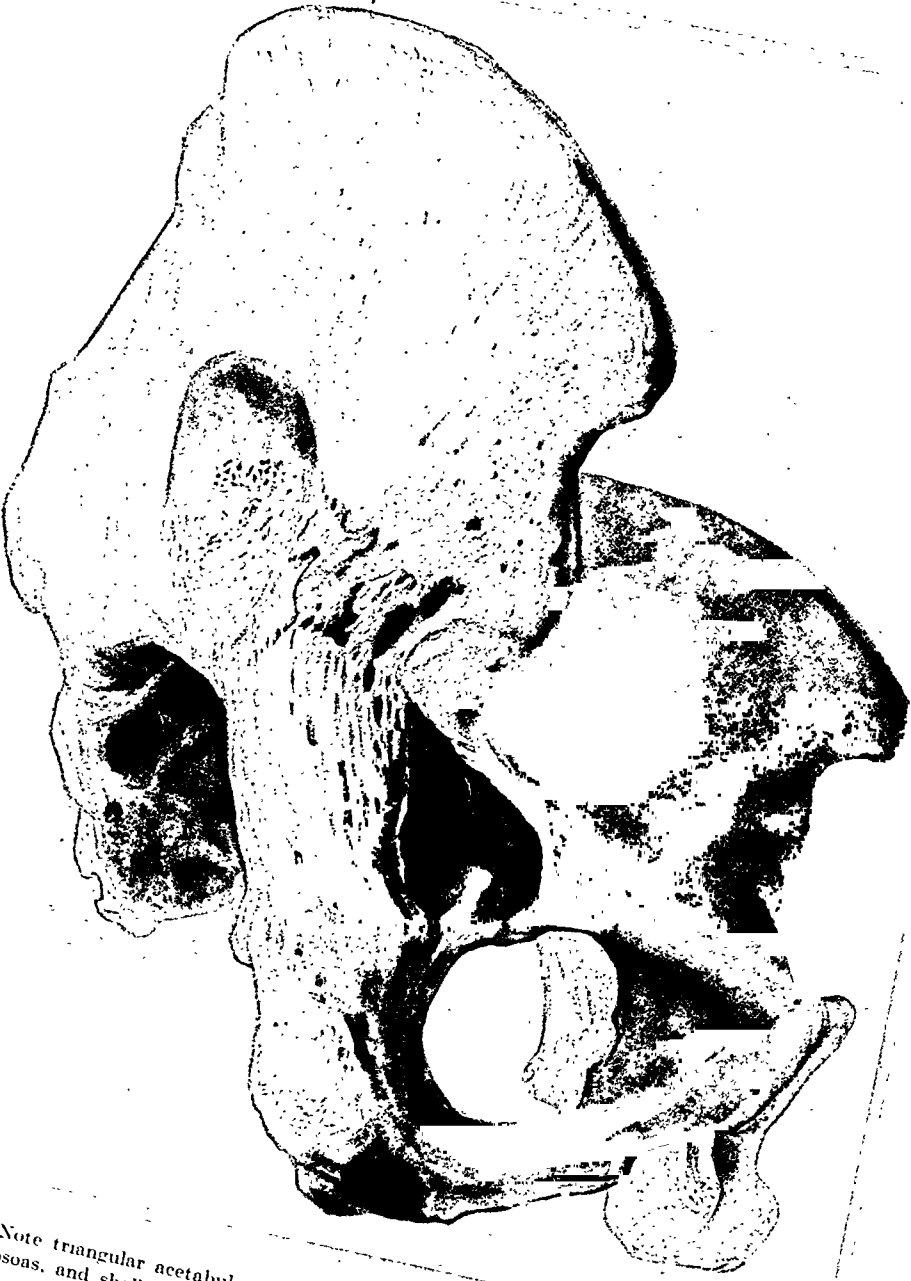
FIG. 199.—Note triangular acetabulum; well-marked retro-acetabular impression; groove for psoas, and shallow false acetabulum. (*Musée Dupuytren* 745. R. side.)

Fig. 200.—Left side of pelvis shown in *Fig.* 199. Note deep false acetabulum, the result of advanced osteo-arthritis.

FIG. 201.—Note well-marked auricular retro-acetabular impression. Deep groove for psoas. No sign of false acetabulum. (*Musée Dupuytren* 740A.)

may be present, a point very difficult to make sure of, but even this may well be secondary. The malformation involves not only the cotyloid ligament, but also the cartilaginous margin, and even the bone—as may be clearly seen in radiograms taken within a few months of birth. Before many years have passed the acetabulum becomes triangular, with the base towards the obturator foramen and the apex pointing upwards and backwards. One specimen estimated as being about 9 years of age has a distinct suggestion of this triangulation. Bowlby[7] reported a well-marked triangular acetabulum at 13 years. This triangulation is the result of the continued growth, unchecked by the pressure of the head of the femur, of the antero-superior and the posterior boundaries of the socket. In the case of the latter the growth is excessive, in response to the unusual stresses and strains induced by the dislocation, as will be shown later. These margins of the acetabulum are usually straight and sharp, and not uncommonly undercut. In the vast majority of the dry specimens examined the cavity is surprisingly deep, even up to the age of 60 years, but the floor is more or less flat. The edges in some cases are lipped, especially the posterior, which may overhang the cavity to a marked degree. The transverse ligament may be ossified. In the fresh specimens the cavity is to a large extent filled by cartilage and a fibro-fatty overgrowth of the Haversian gland. Hoffa[8] said there was always cartilage in the floor, though this might be covered with fibrous tissue. In one remarkable specimen, unfortunately lacking the femora, in the Dupuytren Museum in Paris, both acetabula are practically filled by an overgrowth of the ischium, which forms a nodule on each side (*Fig.* 198). The obturator foramen is more triangular than normal ; the pubic angle is increased ; the ilium is shorter and broader than normal ; and the anterior border is prolonged in the vertical direction and displays a wavy outline. The anterior inferior spine is twisted to conform to this outline, being convex inwards above and outwards below, the latter corresponding to a well-marked groove for the ilio-psoas tendon.

On the dorsum ilii, in adolescents and adults, there is usually something to be seen in the way of a false acetabulum. Even in adults this may be nothing more than a shallow pond, more or less circular, with but a faint rounded margin. As a rule this pond is considerably larger than the femoral head, which rests in or against it, and this disproportion in size suggests there must be considerable mobility of the femur, in an antero-posterior as well as a vertical direction. It may show one or more raised flat-topped bosses, with smooth, eburnated surfaces (*see Fig.* 208). In some cases the edges are well developed, while occasionally a deep hemispherical cup with a polished eburnated floor is seen. Such a well-formed false joint is clearly the result of osteo-arthritis, and is associated with similar changes in the femur. In a bilateral case these arthritic changes may be present to a marked degree on one side while they are entirely absent on the other (*Figs.* 199, 200). The false acetabulum may be represented by a large facet, slightly hollowed and raised above the level of the surrounding bone. and with a polished surface and sharp edges (*see Fig.* 202). In situation it may be high or low. more anterior. or far back close to the great sciatic notch. In some it is difficult to determine where the head rested. unless against an area of thickened bone just above and behind the acetabulum ; this may or may

not be continuous with the rough impression on the ischium shortly to be described.

Of 38 hips in which a visible false acetabulum was expected, it was a mere shallow hollow with little or no margin in nearly half (17). In 9 specimens there was no sign of a false joint, while in 9 a well-marked arthritic socket, with lipped margins and an eburnated floor, was present. In one case the ilium showed facets but no hollow.
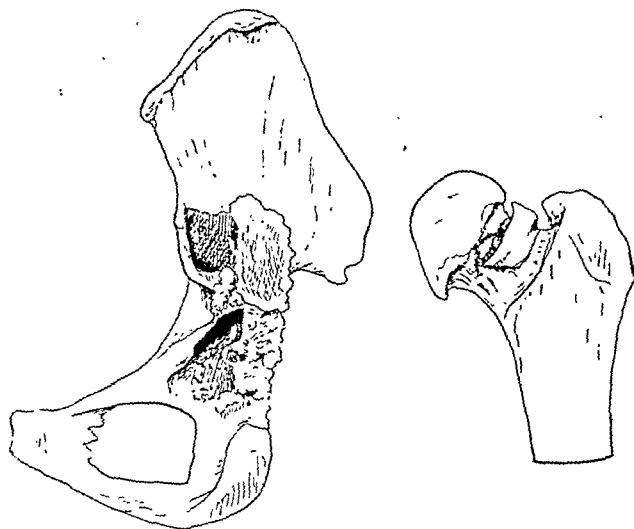
FIG. 202.—Note false acetabulum, a slightly hollow, raised facet. Retro-acetabular impression shows polished, pitted surface with sharp margins, encroaching somewhat on acetabulum. Deep hollow between inferior iliac spine and false acetabulum. Femur shows raised facet on neck. Slight lipping of head. (*Musée Dupuytren* 749B.)
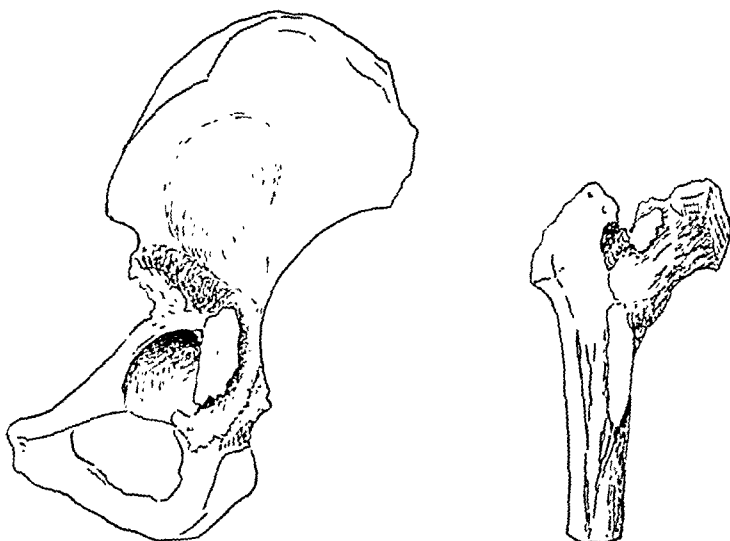
FIG. 203.—Note retro-acetabular facet, slightly overlapping acetabulum. False acetabulum shallow, but extensive, with deep groove below it. Femur shows flattening of head, two facets on neck, and facet replacing lesser trochanter. (*Musée Dupuytren* 757P.)
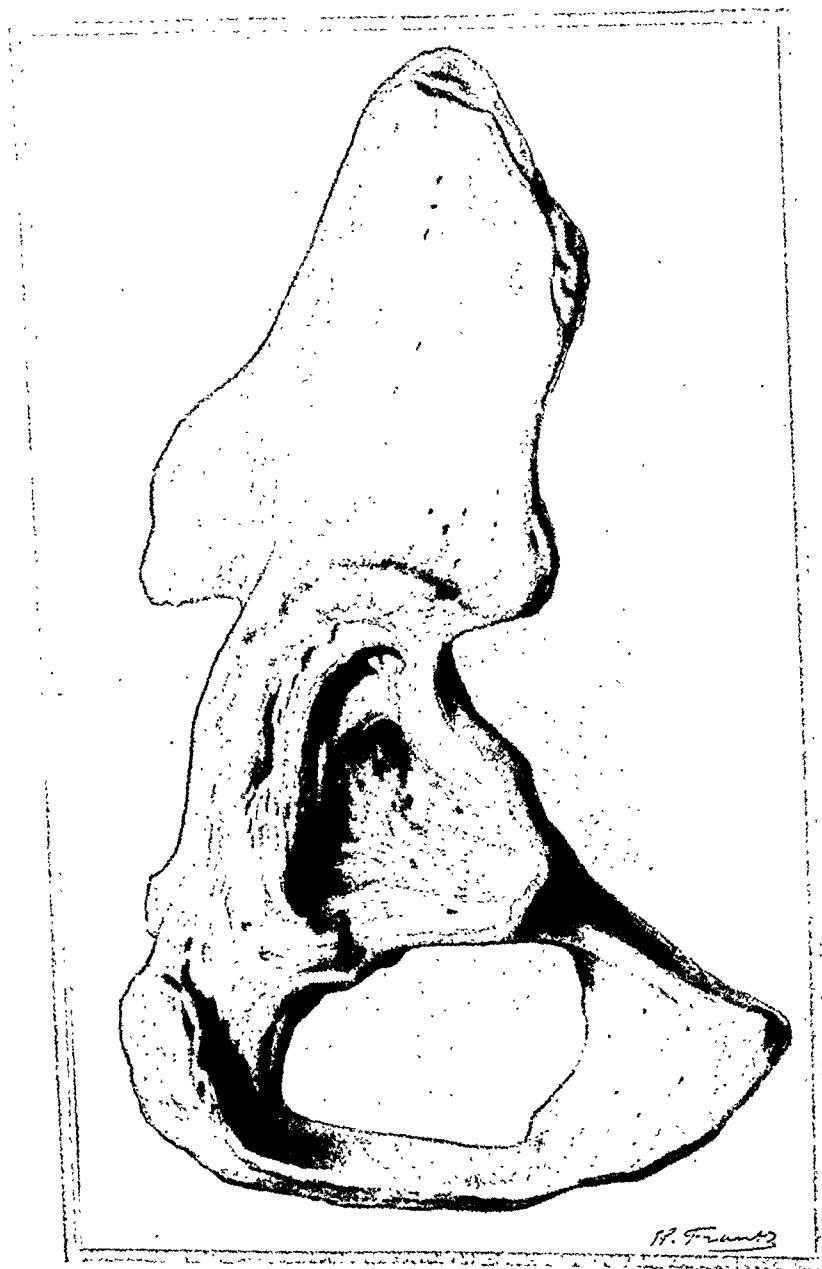
FIG. 204.—Note well-marked auricular retro-acetabular impression. No sign of false acetabulum. (*Musée Dupuytren* 747F.)

The ischium shows perhaps the most remarkable changes of any of the bones, yet it has received but scant attention from surgeons. It is usually said that the tuber ischii is everted, but this is hardly an accurate description of the changes found. On looking at the bone that lies behind the acetabulum, formed by the ischium below and ilium above, in most adult cases we find the normal smooth, slightly convex surface profoundly changed. It may be simply roughened, with many pits, ridges, and nodules; it may be raised into a definite ridge with a similar roughened surface; while it may present a raised articular facet with a smooth polished surface of varying size (*Figs.* 201, 202, 203).

In 8 of the 36 specimens in which this area was exposed there was nothing very remarkable about the bone. In all the remaining 28, however, notable changes had taken place. In 8 what may be termed the retro-acetabular impression showed an unusually roughened surface; in 9 a definite broad ridge was seen; while in 8—with the possible addition of a ninth—there was a facet.

As will be seen later, the joint cavity overlaps this surface, and this extension might account for the striking smoothness noticed in a few specimens (3). The excessive roughness and the thickening of the bone are due, I suggest, to the excessive strain that has to be borne by the hypertrophied ischio-capsular ligament, which is here attached. The facet, when present, is due to pressure and friction against the lesser trochanter, which shows similar changes. The 'impression', whether only roughened or ridged as well, may extend above and forwards over the top of the joint to form an auricular shaped surface (*Fig.* 204). When this auricular impression is seen it seems possible—even probable—that the head of the femur had rested opposite the upper part of it, since no sign of a false acetabulum is found higher up. When facets are present on the pelvis and femora these have not necessarily been in direct contact—in fact, in most cases, and perhaps in all, the capsule has intervened between the bones. As I hope to show presently, the postero-inferior portion of the capsule is not attached close to the acetabular margin, but some distance farther back—in some even as far back as the posterior margin of the retro-acetabular impression. The ischial facets are in front of the capsular attachment and are therefore within the joint cavity. The facets are usually single, but in the Royal College of Surgeons Museum is a specimen showing three. In size they may be as small as a sixpence, while the largest seen measured $2\frac{1}{4}$ by $1\frac{1}{2}$ in. In this case the facet has spread forwards over most of the old acetabulum (*see Fig.* 210).

The Femur.—Even in young children the head is smaller than normal, though relatively large compared with the acetabulum, while the ossific centre is late in its appearance, and smaller than that of the normal femur. Before long the head becomes flattened by pressure against the ilium on its inner and posterior aspect, while less commonly it is also flattened in front and on top. The head then suggests a wedge rather than a cone, the edge of the wedge lying in a plane which runs downwards and forwards (*Fig.* 205). A conical head may be seen, but is rather less common. Bowlby[9] described such a head, the apex of the cone corresponding to the stump of the

ligamentum teres, which had disappeared. In some cases, and particularly in adults, much greater changes are seen : these are of two kinds—namely, erosion and lipping—either of which may predominate. The amount of erosion varies from a slight pitting of the cartilage surface to complete disappearance of the head. After much forcible manipulation pitting has been met with in a case only 4 years of age. Lipping may be seen at the lower margin only of a conical or otherwise misshapen head, while it may produce a typical mushroomed head with little or no erosion. When combined with erosion and
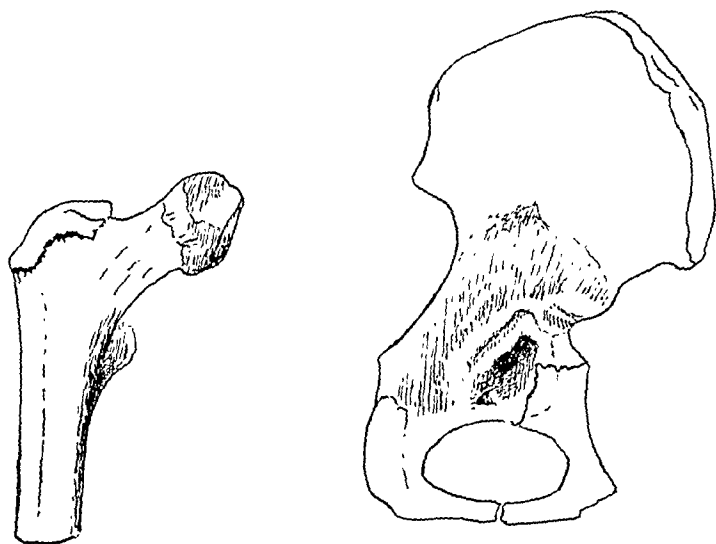
Fig. 205.—Pelvis shows very shallow acetabulum, with rounded margin, and above and behind it an extensive auricular impression. Femur shows a well-marked wedge-shaped head. (*Musée Dupuytren* 739A.)

eburnation it produced the appearances characteristic of advanced osteoarthritis. In adults one is sometimes surprised by the rounded contour of the head as seen in a radiogram, though it is common enough in such cases to see the head reduced to an irregular knob much smaller than the normal (*Fig.* 206). Bradford and others[10] found flattening of the head present in all cases of 10 years and upwards. Gill,[11] in the light of his operative experience, says the cartilage is loosely attached to the bone and easily detached by force even against the acetabular margin.

As to the museum specimens: in most of the youngest, as well as in 2 of the adults, the head was of fairly good shape ; 5 showed wedging as against 4 with a conical head ; in one the head was flat above and inside : 10 showed marked irregularity in shape and lipping ; 5 showed advanced erosion; in over half (17) there were definite signs of arthritis of some kind.

In two femora with conical heads was seen a curious circular groove running at right angles to the axis of the cone, and presumably due to pressure by a fold or ridge in the capsule (*Fig.* 207).

Fig. 206.—Acetabulum prolonged upwards as a groove surrounded by roughened bone. Retro-acetabular impression shows roughness typical of ligamentous strain. Transverse ligament ossified. (*Mus. Lingston 713b.*)

The neck of the femur may be normal in length, but is often short and slender. The older the patient the less likely is the neck to be normal, not only as to its length, but in other ways. Coxa valga, often more apparent than real in a radiogram, may be present, but coxa vara is much more frequently met with, though not so commonly before as after reduction. Of 32 femora of all ages examined regarding this point, only 9 showed definite coxa vara ; the worst of these showed a right-angle deformity.

As to antetorsion, stress has been laid on this by most writers, many attributing their failure to maintain reduction in some cases to the presence of this deformity. Farrell, von Larkum,

FIG. 207.—Note circular groove on femoral heads. (*Musée Dupuytren* 741A and 748.)

and Smith,[12] by taking radiograms in the neutral and the fully inverted positions, estimated the antetorsion in 336 cases. In nearly half the angle was over 20° ; of these about half gave an angle of 20° to 50°, while in the remainder, i.e., nearly a quarter of the whole, the angle was over 50°. While admitting the great difficulty of accurate estimation, they conclude that antetorsion is a factor of considerable importance. On the other hand, in 1000 cases, Froelich[13] found an extreme degree of antetorsion in only 1 per cent. Whitman[14] suggests that an angle of 35° is normal at birth, and that this is gradually reduced, by tension of the capsule, to 15° to 10°. If the hip is dislocated, this reduction does not take place. My own impression is that while an angle above the normal is extremely common—almost the rule—extreme degrees of antetorsion rendering permanent reduction an impossibility are rare. In one remarkable case met with at the age of 9, with 2½ in. of shortening, *retro*torsion was present, the head lying behind the trochanter. This patient only commenced to walk in her fifth year. The accurate estimation of the angle of antetorsion in the living subject is a matter of considerable difficulty. I am greatly indebted to my friends, Drs. Shires and Graham Hodgson, for the trouble they have taken to help me in this matter.

The most promising method for research seems to be that suggested by Stewart and Karshner,[15] though this has the disadvantage of depending on the use of the screen, in a darkened room. The patient lies prone, with the knee on the affected side flexed to a right angle, and the tibia vertical. The foot is carried over towards the sound side. i.e., the femur is externally rotated until the head, neck, and shaft appear to be in a line. By means of a graduated arc and pointer this angle is measured ; the result subtracted from 90 gives the angle of antetorsion. They say that the margin of error is not more than 5°.

In the 26 museum specimens in which this could be noted. only the upper few inches of the femur being available in most. the angle of antetorsion was estimated as varying between 0° (3 cases) and 75° (1 case). In no fewer than 11 the angle was about 45°. while the average worked out at 30·6°—not a very high angle, be it noted.

A feature of considerable interest is the finding of smooth polished facets on the neck of the femur. These I found on 7 femora, in 2 of which two separate facets were seen, one in front and the other behind, close to the

FIG. 208.—Note retro-acetabular facet overlapping acetabulum. Raised facets in floor of false acetabulum. Femur shows conical head, facet on neck, and pronounced tubercle on anterior inter-trochanteric line. (*Musée Dupuytren* 749C.)
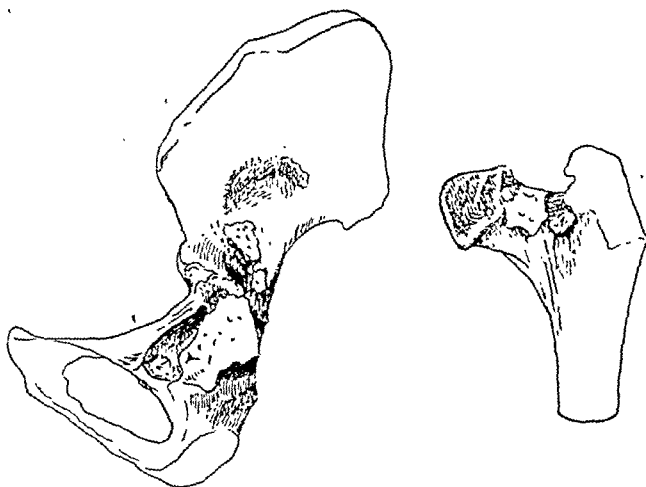
upper surface of the neck. In the other 5 only one facet was present, and this was situated high up on the anterior surface; in 3 of these it extended on to the superior surface. The facets are not extensions from the head, but are quite separate from it (*see Figs.* 202, 203, 208). They were raised above
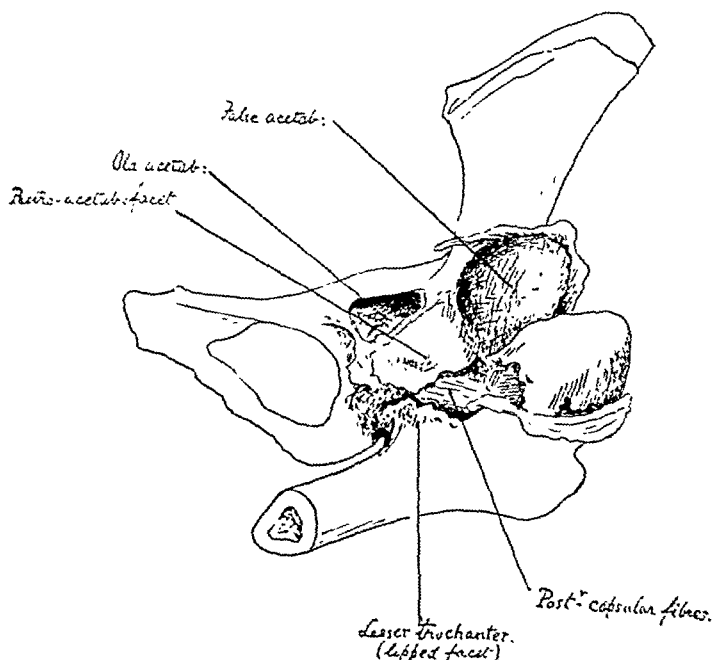
FIG. 209.—Note large retro - acetabular facet with ischio - capsular band attached *behind* it. Acetabulum shows sharp margins and ossified transverse ligament. False acetabulum and head of femur show marked osteo - arthritic changes. Lesser trochanter shows lipped facet. (*Musée Dupuytren* 746.)

the level of the surrounding bone—in some cases markedly so—and from their shape and grooved surface unquestionably took the strain of the capsular sling. In other specimens, devoid of facets, the grooving of the neck above was at least suggestive of unusual pressure.

In some femora (7 in this series) the tubercle near the upper end of the anterior intertrochanteric line, for the attachment of the iliotrochanteric band, was particularly well developed (*Fig.* 208); in others it was entirely absent.

While in children the lesser trochanter is normal, in adults it may show most striking changes. It may be entirely absent, be represented by a flat elongated area with a faint raised margin, or finally it may be well formed but have at its apex a flat facet. This facet may have a smooth eburnated surface, with an overhanging lipped margin, and varies considerably in size. In those showing the largest facets, the process is much elongated in the vertical direction (*see Figs.* 203, 209, 210).

Our findings in the museum specimens were as follows : normal in 12 ; facet present in 8, possibly 9 ; entirely absent in 1 ; very prominent and lipped without definite facet in 2 ; and situated abnormally low in 1. Six specimens were too young to show any change.

FIG. 210.—Note extremely extensive facets behind acetabulum and on lesser trochanter, and the presence of capsule behind the facet on ischium. False acetabulum and femur show marked osteo-arthritic changes. A portion of capsule has been left arching over neck of femur (capsular sling). (*Musée Dupuytren* 753C.)
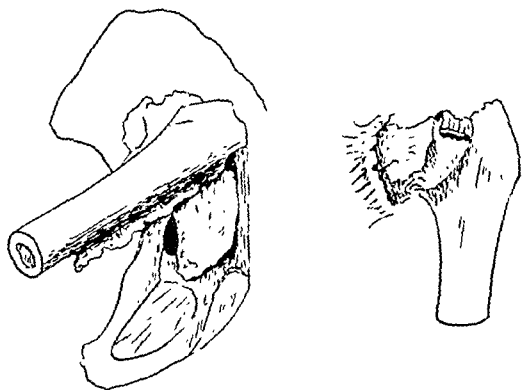
As a rule if there is a facet behind the acetabulum, there is a corresponding facet on the lesser trochanter, but in one bilateral case in the Dupuytren Museum the femora show facets while there are only well-marked ridges, without facets, on the pelvis.

X-ray Evidence.—After childhood the development of the retro-acetabular ridge and the presence of facets at this spot and on the lesser trochanter can often be seen in the radiograms of untreated cases. and also in many where relapse, partial or complete, has followed reduction (*Fig.* 211). At first it was thought these facets would only be found in the presence of adduction deformity, but this proves to be incorrect, for recently a case was seen with a full range of abduction, and yet well-marked facets were shown in the radiogram. As a sign of instability after apparently successful treatment. thickening of the ischium is of considerable value. but cannot be relied on absolutely. Though to be seen in most cases showing imperfect acetabula. it is occasionally absent when the joint is obviously unstable or even subluxated. Two other anatomical peculiarities have been revealed by X-ray examination. The first is a loose fragment of bone. not unlike a sesamoid, at the back part of the tuber ischii. This has been met with three times : the origin of this fragment is doubtful, and may not be the same in each case

(*Figs.* 211, 212). The second, seen in a few cases, is a prominent tubercle situated a little below the level of the upper lip of the acetabulum (*Fig.* 213). This seems to be an outgrowth of the posterior margin of the socket. ·

FIG. 211.—Radiogram of left hip of woman of 26 (unsuccessful reduction at age of 5). Note facets on pelvis and lesser trochanter. Ischial tuberosity shows loose bony fragment.
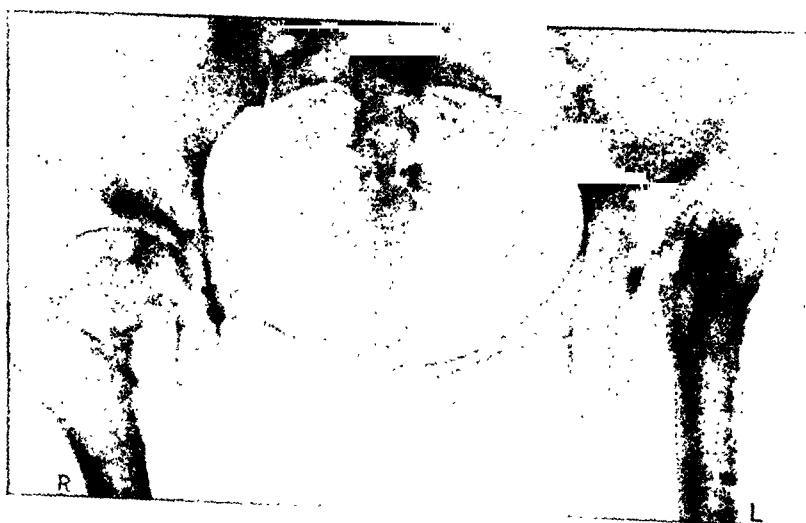
FIG. 212.—Radiogram of bilateral dislocation. Woman of 21 years. Reduction at age of 5. Note ischial projection with large loose fragment on left.

The bones of the leg may be either shorter or longer than those of the opposite limb. As much as half an inch of shortening has been noted between the tip of the trochanter and the external malleolus before reduction,

while the foot is frequently smaller than its fellow. On the other hand the shortening, as measured in the usual way, may be less than the radiogram would lead one to expect. A boy of 10 with a subluxation of the hip showed the affected leg nearly half an inch longer than the other. After successful reduction we have found the limb longer than the other in many cases, the greatest difference noted being three-quarters of an inch ten years later.

Fig. 213.—Bilateral dislocation, girl of 12 years, untreated. Note tubercle on each side just below level of upper acetabular margin.

The Capsule.—The general arrangement of the capsule has been well known for many years. As the head migrates upwards it carries in front of it a dome of the capsule which blends with the periosteum above and behind the acetabulum. Where this fusion occurs in the floor of the false acetabulum, the two are transformed into fibrocartilage. In response to the abnormal strain to which it is subjected, the capsule, though lax and thin at first, becomes thickened, the thickness attained varying considerably in the different portions of the capsule and in different cases. It may be as much as a third of an inch in thickness in a child of 13 years. It is generally said to be thickened in front, the part, be it noted, where it is almost invariably incised by the surgeon. The presence of a well-marked tubercle on the front of the femur suggests great strength in the iliotrochanteric band. It is particularly strong below, where it is often divided by the surgeon to enlarge the isthmus, and where it is in close relation to the psoas tendon. Bradford[16] noted the strong bands passing to the lower part of the neck and the region of the lesser trochanter. The ischiocapsular band behind is always thickened, and is, I believe, of special importance. Shattock[17] described it as 'specially strong', while Bennett.[18] in one case, found the posterior capsule cut like fibrocartilage. As already stated, this band is attached, not close to the posterior margin of the acetabulum, but some distance behind it, and rather

FIG. 214.—Capsular sling has been left in place. Note capsular isthmus adjacent to femoral neck and drawn well away from pelvis. (Musée Dupuytren 749.)

obliquely, and when a retro-acetabular facet is present the attachment is along its posterior margin (see Fig. 209). These ischio-capsular fibres, much increased in numbers, pass upwards to arch over the neck of the femur and blend with the strong fibres in front that are attached to the anterior margin of the acetabulum and transverse ligament. In this way is formed a powerful sling which passes over the neck as over a pulley, and prevents further upward displacement of the femur (see Figs. 210, 214, 220). Whether plaques of bone or cartilage are ever formed in this capsular sling to correspond to the facets noted on the femur we have been unable to discover. Though the capsule lying over the neck is always thickened, and that over the head generally so, this is not invariably the case. In a young woman operated upon at 24 years, the capsule hardly existed over the head, where the reflected head of the rectus blended with it.

The ligamentum teres is usually present in young children, and frequently absent in the older cases. Increased age, greater displacement of the femur, and previous manipulative treatment are three factors that contribute to its disappearance. Hoffa[19] found it absent in 27 per cent of 200 cases, while Galloway[20] found it surprisingly large in cases not previously manipulated, and usually absent after this method of treatment had been tried. In the majority of cases the ligamentum teres is of no importance whatsoever, but occasionally it is of sufficient size to interfere materially with satisfactory reduction. In a child of only $2\frac{1}{4}$ years it formed a slab $\frac{5}{8}$ in. wide and $\frac{1}{4}$ in. thick, and this interfered with stable reduction.

The hour-glass shape of the joint cavity is well known and needs no special description. Hoffa[21] was the first to note the importance of the psoas tendon in accentuating the so-called isthmus between the true and false joints. It is sometimes forgotten that a well-marked isthmus can only be present when the head is completely dislocated, and must therefore be rare in the younger children. Only once have I seen a well-marked isthmus under three years of age.

FIG. 215.—Diagram of arrangement of acetabulum on right side of bilateral case, age 4 years, to show capsular fold which descends in front of head during attempted reduction.

A, Fold of capsule ; B. Cartilaginous margin of acetabulum ; C. False acetabulum ; D, Acetabulum.

Now the cavity always extends to some degree backwards over the retro-acetabular impression. In the foetus this is easily explained by the size of the head from before back, its undue mobility, and the fact that as yet the displacement is slight. But why should this arrangement persist into adult life. as it certainly does in some cases, if not in all ? There may be quite a definite sharp fold of synovial membrane, placed vertically and standing up into the cavity between the acetabulum proper and the retro-acetabular smooth area (see Fig. 217). This fold corresponds in position to the rounded posterior margin of the acetabulum in young children. It was seen in some of the museum specimens. but only once during an operation. and then. curiously enough. in a child of only 20 months whose hip was opened for

persistent relapse after reduction and fixation. On the posterior wall of the joint in this case was seen a vertical white band. But there is another fold which I believe has never been described, and which was first noted in a bilateral case, the patient being 4 years old. This fold, as can be seen in the diagram (*Fig.* 215), lies more or less horizontally, but is inclined slightly downwards as well as backwards, and is situated just above the position of the upper acetabular margin. It may be pale and yellow in colour, or red if the joint is inflamed. It is soft and not cartilaginous, and is, in fact, a fold of the synovial membrane and capsule just above the acetabulum. When weight is borne on the leg the capsule and synovial membrane are put on the stretch above, and the fold disappears, only to reappear as the tension is relieved. When, during attempts at reduction, the head is forced down
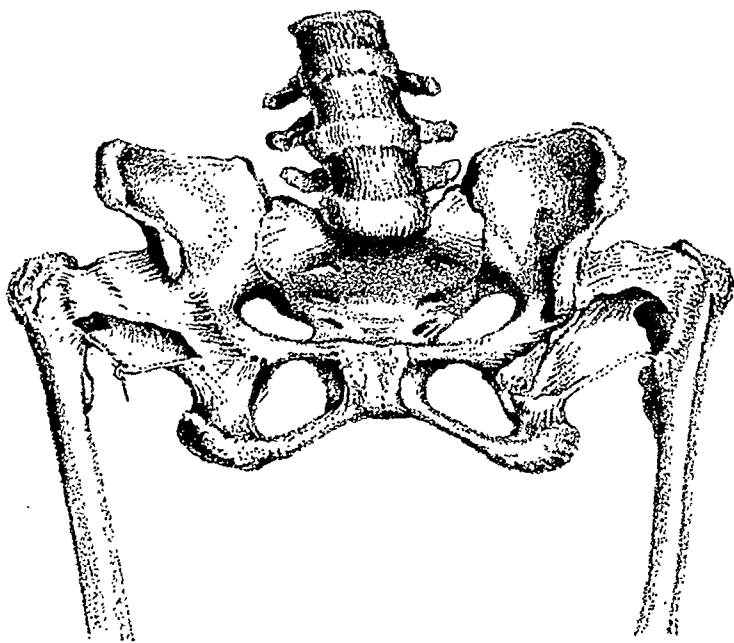
Fig. 216.—Illustration in Carnochan's book. Bilateral dislocation showing isthmus close to femur and bounded on inner side by fold stretching out from pelvis.

towards the socket, this fold is piled up on the acetabular margin and increases the difficulty of forcing the head over it, a difficulty that might be lessened by lifting or pushing the head towards the socket as opposed to levering it in. Z. B. Adams[22] mentions a band seen deep in the socket at the back, which he thinks was " possibly a thickened cotyloid ligament folded in before the head at the first reduction ". It is possible that he is referring to a fold similar to that described above. Unfortunately in comparatively few museum specimens is much of the capsule present, and even in these it is usually dried, but in a few may be seen a fold standing out boldly, and presenting a crescentic outer margin which bounds the isthmus on its inner side (*Figs.* 214, 216, 217). In these specimens, in which it is admitted the femur has been drawn somewhat away from the pelvis, the isthmus lies close to the femur, and

not, as might have been expected, close to the ilium. One of Carnochan's[23] illustrations (*Fig.* 216), the bones of which specimen are preserved in the Museum of the Royal College of Surgeons, shows this condition on both sides. It is suggested that this fold with the crescentic margin is an accentuation of that observed in childhood. The cavity of the joint may be said, therefore, to consist of three portions, one corresponding to the old acetabulum, another over the anterior and upper part of the retro-acetabular bone and separated from the first by a vertical fold, and a third, above, corresponding to and enclosing the displaced head of the femur (*Figs.* 217, 218). During manipulative reduction the head of the femur traverses the second or retro-acetabular compartment, on its way from the third to the first. If the isthmus is very
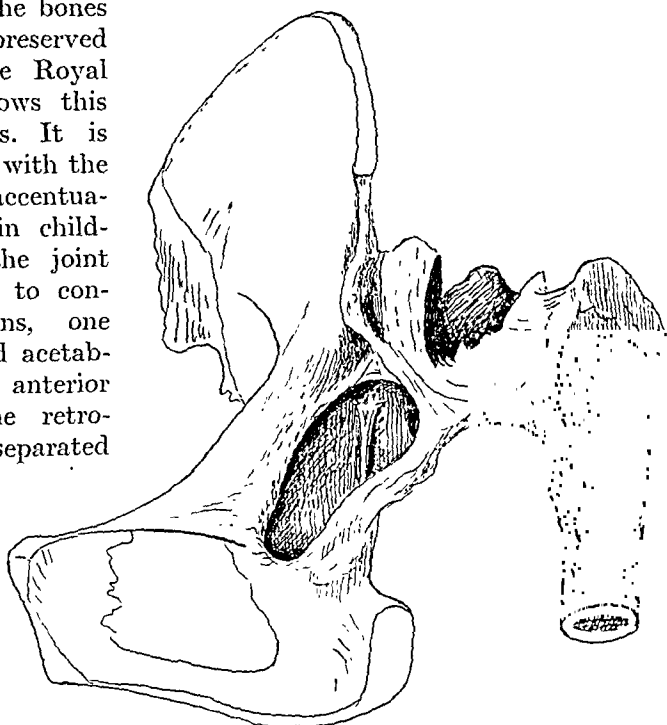
FIG. 217.—Dry specimen with windows cut in capsule. Note vertical fold between true acetabulum and retro-acetabular surface, and, above and outside this, capsular isthmus. (*Musée Dupuytren* 753.)
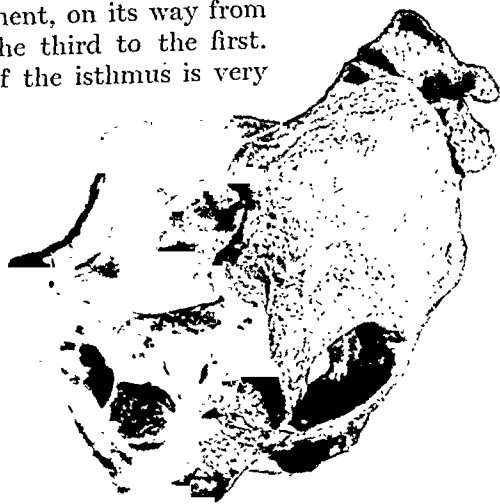
FIG. 218.—Dry specimen showing definite ridge (vertical in photograph) between acetabulum and retro-acetabular surfaces below and false acetabulum above. (*King's College Hospital Museum.*)

small, the highest compartment may be almost shut off from the other two. One specimen in the Dupuytren Museum, collected by Broca in 1848, shows the joint cavity completely divided into two.

THE MUSCLES.

The muscles are of interest and importance.

The Adductors. — These are always shorter than normal. Except in the youngest children they offer resistance to complete reduction, and in all cases they have to be stretched or ruptured before a stable position for the reduced hip can be obtained.

The Rectus Femoris.—The direct head of the rectus, in most cases, runs a straight course in front of the capsule, the whole muscle being shortened. But when the dislocation is more directly upwards, this tendon arches forwards over the capsule, and obviously assists in the stabilization of the head. It probably serves this purpose after 'anterior transposition', and when a marginal displacement follows reduction. A bursa may be present between the capsule and tendon. The reflected head in most cases is displaced from its normal attachment to the bone by the dome of the capsule, over which it arches backwards and to which it is attached. Occasionally it retains a portion of its bony origin, and still more rarely it may be found arising from the ilium high up above the false acetabulum, or even in front of this.

The hamstrings are short but of little importance, since they are easily relaxed by flexion of the knee during reduction, and can be stretched without difficulty later. The sciatic nerve is short, but can be relaxed like the hamstrings, and should not be in danger even when the shortening is considerable, if the knee and hip are kept flexed during reduction and the former is not extended too forcibly afterwards. Damage to this nerve has occurred during reduction as a result, I think, of bruising by a wedge or other fulcrum, rather than by stretching. I am convinced this was so in the solitary instance in which I produced a temporary paralysis of this nerve.

The Ilio-psoas.—This is important. Instead of the tendon, which is formed unusually high, passing downwards with a slight inclination backwards, it passes very decidedly backwards and outwards, in close contact with the capsule in the region of the isthmus. When the femur is much displaced, the pelvis tilted, and the lordosis marked, this tendon takes a practically horizontal course after leaving the pelvis. The strain put upon it is shown by the deep groove seen in every adult specimen below the anterior inferior spine. Jackson Clarke[24] says the tendon may be cartilaginous where it traverses this groove. The muscle and tendon unquestionably act as a sling to support the pelvis on the femur, while Carnochan[25] and Tubby[26] both suggest the pull of the psoas is responsible for the lordosis. Possibly this is correct, but the shifting backwards of the point of support must be regarded as of paramount importance in this respect. While Bradford and Lovett[27] describe the ilio-psoas as short, Lorenz[28] says it is long. We are inclined to agree with the former, and to regard the division of this tendon, as suggested by Burghard,[29] as an important item in the technique of open reduction.

The Glutei.—These are said to be unaltered in length, presumably because the trochanter is displaced outwards as well as up. In all cases with much displacement the gluteus medius, particularly the fibres which arise nearest the crest, must be shortened, but in the younger children there can be little change in these gluteal muscles, or we should never obtain reduction with such ease and certainly never retain it with the trochanter lying at a lower level than the head, which is the state of affairs invariably seen in radiograms with the limb in the Lorenz position. The gluteus minimus is in close apposition to the capsule, into which it is partly inserted, and from which it is separated with some difficulty. This muscle stabilizes the head by holding it against the ilium and by strengthening the dome of the capsule. It

is not a strong muscle, however, since its normal attachment has been usurped to a large extent by the dome of the capsule.

The Horizontal Group of Muscles.—These muscles, i.e., the obturators, gemelli, and quadratus, are lengthened and the direction of their fibres is altered. They no longer run horizontally, but pass upwards and backwards to reach the trochanter; they serve a useful purpose as slings for the pelvis (*Fig.* 219). Both the obturators would seem to be particularly useful in this way, the external because even in the normal hip its direction is slightly upwards, and the internal because of the pulley round which it turns as it leaves the pelvis. These muscles assist in keeping the femoral head home in the false acetabulum. After reduction no doubt they are slack, but, so long as the limb is in the right-angle position, their place is taken in this respect by the adductors and hamstrings. The desirability of restoring the short muscles to a taut and vigorous condition before the leg is allowed to return to the vertical position, is an argument in favour of encouraging
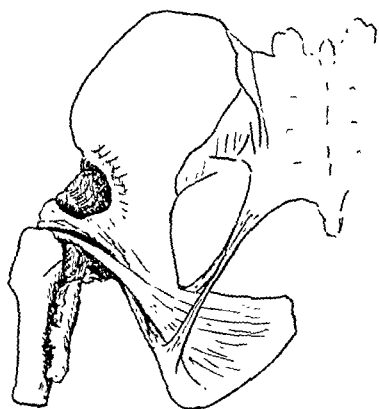
FIG. 219.—Same as *Fig.* 210, from behind, to show obturator internus muscle and large facet on lesser trochanter.
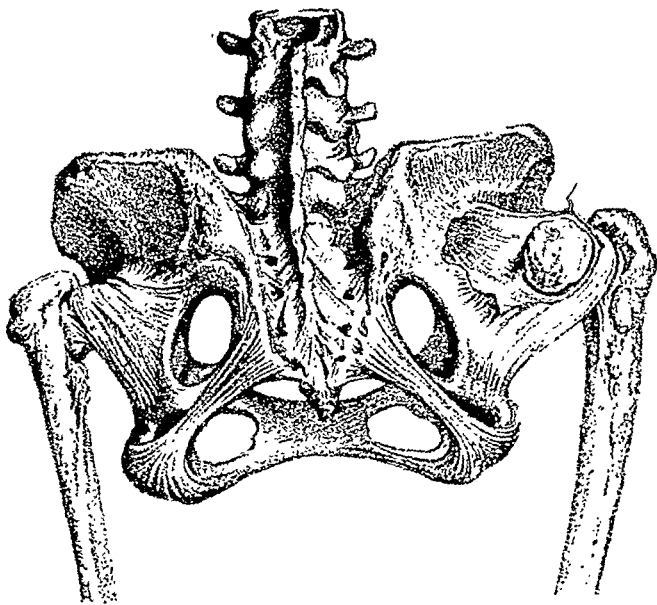
FIG. 220.—Posterior view of *Fig.* 216. Note capsular sling on each side.

walking during the period of plaster fixation. and of not including the knee in the cast.

Having considered the anatomy in some detail. it should now be possible

to form an opinion as to the method of suspension of the pelvis on the femur when the latter is dislocated. To begin with, it seems clear that, except in the ultra-arthritic case with gross lipping of the false joint, the bones have little or nothing to do with it. The work appears to be shared by the capsule and the muscles, as our knowledge of anatomy would lead us to expect. The capsular strain is taken by the thickened bands passing from pelvis to femur in front and below, but particularly by the *capsular sling* arching over the neck (*Fig.* 220). The muscles which assist the capsule and prevent further stretching of this sling are the ilio-psoas in front and the obturator group behind, while the gluteus minimus gives such help as it can.

THE LIMP.

Why does a patient with a congenital hip walk in the characteristic manner? Why must the body weight be thrown towards the affected hip by a cast of the shoulders? Obviously because the abduction power at the hip-joint is diminished. But why is this diminished? Four possible explanations strike one at once: (1) The instability of the fulcrum; (2) Deficient power of the abductors; (3) Diminished leverage for these muscles; and (4) Shortening.

1. **The Instability of the Fulcrum.**—It must be remembered that the femur, though greatly displaced, is prevented from riding up indefinitely on the dorsum ilii. After a variable number of years, twelve or thirteen according to Simpson,[30] it ceases to migrate, and long before adult age is reached its progress is stayed by the capsule and muscles, so it is difficult to believe that this is the sole or main factor.

2. **Deficient Power of the Abductors.**—The abductor muscles, it should be remembered, have developed with the femur displaced, and have not been relaxed by any rapid migration of the femur as occurs in a pathological dislocation. The glutei, however, are diminished in strength because the area from which they can arise from the ilium is reduced by the presence of the displaced capsule. We have to admit, therefore, that these abductor muscles are weaker than normal, but that they may rapidly become equal to their task is proved by the perfect gait assumed a few months, even a few weeks, after removal of the plaster cast when a successful permanent reduction has been accomplished.

3. **Diminished Leverage for the Abductors.**—As to diminished leverage, there are three levers the lengths of which have to be considered. These levers are represented diagrammatically in *Fig.* 221, a plan slightly modified from that suggested by Girdlestone[31] for pathological dislocation.

But the abductor muscles can be considered from another point of view. We can take it, I think, that the result of the combined effort of the abductor muscles in supporting the pelvis on the normally articulated femur acts in the transverse vertical plane of the body. The fact that the head normally lies in a plane anterior to that of the trochanter is allowed for by the glutei being attached to the front rather than the back of this process. When, however, the anteversion of the neck is excessive, is it not possible that these muscles tend to produce a rotation of the femur, a twist of the trochanter

backwards, which has to be checked either by excessive action of the abductor muscle fibres lying to the front, or a diminished action of those behind the plane of movement ?   The result might well be a functional weakness of these muscles.   A further point is that the head, even if stable as regards further upward displacement, is unstable in the antero-posterior direction, as is suggested by the greater size of the false acetabulum in the horizontal plane than the size of the head demands.   As the trochanter tends to rotate backwards during abduction, so the head would tend to slide forwards.   If a
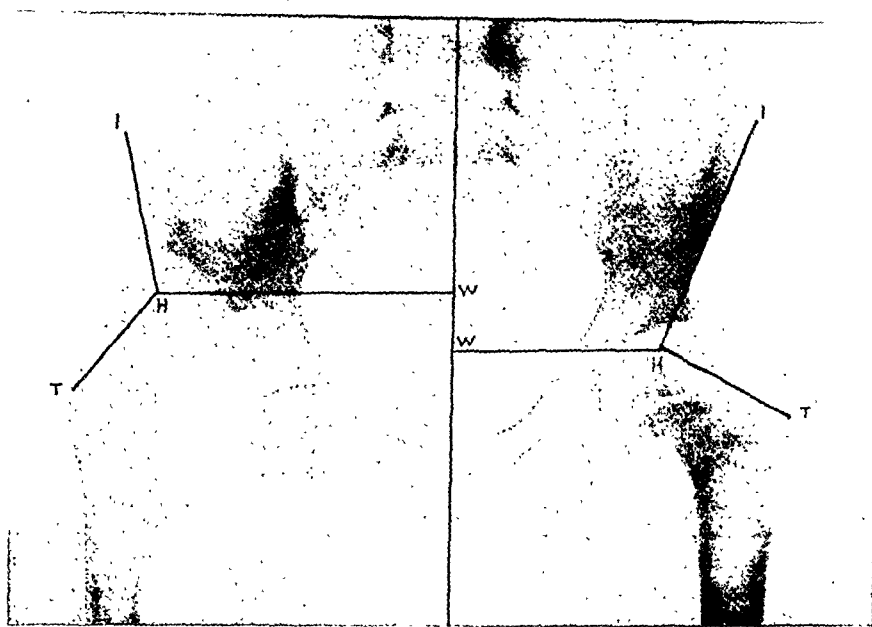
Fig. 221.—Unilateral case to show leverage.   The distance (H T) from the centre of pressure on the head to the trochanter—in the transverse plane of the body—may be normal, but is diminished if the neck is short or the head flattened, and also when the antetorsion is excessive.   The shorter this lever, the weaker the abductor power of the glutei.   The second lever (H I), formed by the ilium and measured from the head to the top of the crest, is always diminished, and often very markedly so.   Even though the first lever happens to be normal in length, the inevitable diminution of the second puts the abductors at a great disadvantage.   Though only one of these levers comes into play at a time—according as the limb is moved on the pelvis or vice versa—the length of the other determines the direction of the abductor muscle fibres and therefore has great influence over their power.   The third lever (H W), formed by the pelvis, is measured horizontally from the centre of pressure on the head to the mid-line, which is taken as passing through the centre of gravity of the body.   Since the femur is always displaced outwards as well as upwards, this lever is always increased in length, and the load the abductors have to support is thereby increased.   When the neck of the femur is of good length, and the upward displacement not extreme, this last factor is possibly the most important of the three.   To sum up, in all cases the abductor muscles of a dislocated hip act under decided mechanical disadvantages.

bilateral case is carefully watched when walking, the upper ends of the femora can be seen to move regularly backwards and forwards.   This instability of the head in all probability plays an important part in the production of the gait.   It is well known that when the dislocated head lies further forward than usual, whether placed there by nature or by the surgeon, the gait is often surprisingly good.   It seems possible that this may be due to the greater

antero-posterior stability as much as or even more than the better vertical stability of the head in such cases. I am not prepared to exclude any of these factors as playing a part in the production of the so-called limp, and each must be kept in mind when considering the treatment of a case in which reduction is impossible. There is yet another factor, however, which occurs to one as not unimportant. If we are correct in attributing to the obturators and their associate muscles the important functions of assisting to suspend the pelvis and to hold the femur pressed to it when weight is borne on the leg, these muscles must also at the same time tend to adduct the femur. If this is correct, the abductors not only have to support the weight of the pelvis, but also to check this adduction pull of the obturators, and this they are unable to do : hence, in part, the rolling gait and the positive Trendelenburg sign.

4. **Shortening.**—The shortening seen in a unilateral case may accentuate the limp, but does not account for it. Compensation for the shortening may diminish, but never corrects, the faulty gait.

PATHOLOGICAL CHANGES.

Now many of the anatomical facts referred to are secondary and patho-logical rather than purely anatomical changes incidental to the displacement of the femur from the socket. The difficulty is to say when changes of form in the head of the femur and false acetabulum end and arthritic changes begin. There is no doubt but that flattening of the head occurs in children, particularly the older ones, without pain or other signs of arthritis, and I think we must regard such changes as due to altered anatomy rather than to arthritis. On the other hand, there is abundant evidence in the experience of every surgeon of the development of gross osteo-arthritis in the false joint. Many surgeons, however, including myself, have been impressed with the frequency of pain and other signs of arthritis in a congenitally unstable or subluxated joint previously regarded as normal, while the opposite hip, completely dislocated, gives no trouble.

Now the arthritis which occurs relatively late in life is essentially trau-matic and the result of instability, but what of the cases that develop pain comparatively early ? Is this pain merely a strain pain, or is it arthritic in origin, and if the latter, is this arthritis infective or simply the early stage of osteo-arthritis ? If due to strain and to stretching of the capsule, insuffi-ciently assisted by the muscles, we should surely expect to find that it is accompanied by further displacement of the femur, but, so far as I know, evidence of this is lacking. It is possible, and I think probable, that the pain in such cases is due to muscle tiredness rather than to stretching of the capsule. Walking is a great effort, especially when the deformity is bilateral. These patients often walk late, and cannot walk as far as normal children of the same age. When increase of weight occurs at puberty, perhaps accom-panied by somewhat impaired health, it is not surprising that greater discom-fort is experienced. Pain in the back experienced by older children may also be due to muscle strain, but occasionally it is sacro-iliac in origin. At the same time definite arthritis, more suggestive of infective than simple trau-matic arthritis, does occur at a comparatively early age in a few cases. I

have met with villous arthritis at the age of 13 in an untreated case.   The head of the femur in this patient displayed but slight erosion and no lipping, the synovial membrane alone showing any marked change.   *Fig.* 222 shows the changes that had taken place in the head of one femur, the left, in the course of twelve months in a patient of 23, who could not walk without assistance. On opening the joint, blood-stained fluid escaped, though no manipulation had been done ; the erosion of the cartilage was evident, the synovial membrane was gelatinous-looking and shaggy, but not villous, while the head had soft areas in it.   This hip had been regarded as normal in childhood, when the other was unsuccessfully treated.   This patient was delicate-looking, but without any discoverable septic focus.*

FIG. 222.—Bilateral dislocation in a woman of 23. The right hip had been treated in childhood ; the left was undiagnosed. Note irregularity of outline of left femoral head, not present a year previously.

I feel sure that the general health of the patient, particularly as regards septic foci, is a very important factor—possibly the determining factor—in the incidence of arthritic trouble at a relatively early age.   Experience of arthritis after reduction gives some support to this view, though trauma as a factor necessarily comes into the picture.   If sepsis is not the decisive factor, how can we account for those cases, by no means rare, in which a woman with one or both hips dislocated will reach the age of 35, 40, or even more without any appreciable discomfort ?   To cite two examples : a woman of 35 in poor circumstances with bilateral dislocation married and had five children, one with a hip dislocated, but never experienced a day's pain ; another woman, in better circumstances perhaps, had a dislocated left hip, was the mother of eight children, and had no pain till she reached her 45th year.   Unfortunately there seem to be no statistics available as to the frequency of gross disability in cases past their childhood.   At present I am not convinced that the pessimistic views held by many, probably by most, surgeons

* Since this lecture was delivered, this patient has developed *infective arthritis* of one wrist.

as to the future of the untreated case are correct.   I admit the serious disability experienced by many, but I do feel that we should not forget that there are quite a number of cases who live well into middle age with little or no discomfort.   Unsuccessful attempts at reduction or transposition must, I think, be regarded as increasing the probability of arthritic changes developing.   This must be kept in mind when a case is not seen until after the usual age limit for reduction is passed.   Pseudo-coxalgia in the untreated case has not been met with either personally or in the literature, though it is relatively common after reduction.   I have no experience of the incidence of specific infections such as tubercle, and the literature gives little help.   Caesarono[32] quotes two cases of tubercle supervening in a dislocated hip, but in only one of these was the nature of the infection definitely proved.

TREATMENT.

Now let us turn to the treatment and see whether any of the above facts and theories can help us.   The objects of treatment are two : (1) To provide a stable joint and obliterate the limp ; and (2) To diminish the chances of

FIG. 223. —Radiogram of congenital dislocation of left hip, twenty years after reduction at age of 2¾ years.

arthritis supervening.   Both these objects are undoubtedly best served by manipulative reduction *at an early age*.   If the hip is reduced before the age of 3, and better still before the age of 2, and a permanent cure results, in a very large percentage of cases the hip will be approximately normal and stand the wear and tear of life almost—though probably not quite—as well as a hip that has never been abnormal.   *Fig.* 223 shows the condition after twenty years in a case reduced at nearly 3 years of age.   It is now almost

twenty-six years since the operation was performed and the patient has a hip that is perfect in every way. *Fig.* 224 shows a hip reduced twenty-two and a half years ago, at the age of $3\frac{1}{2}$. There is a slight increase in size of the femoral head on the dislocated (right) side, but otherwise it would pass as a normal joint. The patient is now a domestic servant, leading a very hard life, with a lot of running up and down stairs, and she says she is tired out by the evening, and then feels the hip that was dislocated. Other similar cases with perfect anatomical results have told me that if they get tired out the reduced hip always troubles them first.

FIG. 224.—Radiogram of congenital dislocation of left hip twenty-two and a half years after reduction at the age of $3\frac{1}{2}$ years.

The older the patient at the time of reduction, the greater the chance of an imperfect anatomical result. In such cases we have achieved our first object, but in all probability have failed in our second. Putti[33] says a congenital hip should be treated as early as possible—that is, as soon as the diagnosis is made—but I am not convinced that there is any advantage in reducing the hip before the age of 18 months, and there are many obvious disadvantages. In most cases the head enters the acetabulum over its posterior margin, after having been brought down to rest on the ischium, over which, as we have shown, the joint cavity extends. If it can be lifted in, as it often can be in the youngest children, before the limb is abducted, so much the better. The synovial fold which, if present, descends in front of the head in the more difficult cases suggests we should take advantage of Ridlon's[34] method of thrusting downwards the fully flexed thigh—the knee being towards the opposite axilla—rather than rely on the abduction leverage method alone. It seems rational, considering the way in which the anterior part of the capsule is stretched across the acetabulum like a lid, that after the head has been apparently reduced, further abduction movements combined with rotation inwards and outwards should be carried out, in order to stretch up this lid and get the head well home. To be convinced of the advantage

of these manœuvres one has only to test the stability of the reduction before and after they have been performed. This seems to me an important part of the operation.

Now there is a growing tendency in the United States, and signs are not entirely wanting of the same tendency in this country, to favour open reduction not only when manipulative reduction has failed, but almost as a routine, even in the youngest children. The decision for or against open operation depends very largely on the view held by the individual surgeon as to the degree of development of the capsular isthmus in young children, and the obstruction this offers to reduction. In 1903 Sir Robert Jones,[35] in the course of the discussion on Burghard's[36] second paper advocating open operation, is reported as having expressed the following opinion : " The causes of failure were . . . sometimes constriction of the capsule, the importance of which was over-rated ". I understand Sir Robert still holds the same views, and I venture to endorse them emphatically. The results of manipulative reduction prove conclusively that in the youngest children at any rate, the reduction is complete in the vast majority. Is it right to inflict the extra risk of an open operation on all because very occasionally—and we must admit this—capsular constriction, an abnormal ligamentum teres, or some less obvious factor prevents a stable reduction being obtained by manipulation ? Simple open reduction, which we owe to Burghard, whose operation comprised the important details of dividing the psoas and enlarging the isthmus, is unquestionably a useful procedure in selected cases, rarely met with before the age of 4, though more commonly afterwards. Even with the help of open reduction I do not think the age limit of 6 for a bilateral and 9 for a unilateral case should be exceeded. Galloway[37] has been the strongest advocate of a more extended use of this method in recent years, but I am not sure that his published results give much support to his views. For instance, he reported a further series of 38 hips in 1926. Of these, the cures were 15 (less than 50 per cent, be it noted), the good results 18, the doubtful 5, and failures none. It is not clear what exactly constitutes a good result which is not a cure and yet not a failure. It must be insisted upon that open reduction *per se* has no advantage whatsoever over the closed method, reduction being complete in both cases. After both the acetabular margin must grow out, and for this prolonged fixation is necessary.

The next question involves the importance of antetorsion, the influence of this on the results, and the advisability of correcting this deformity by osteotomy. Opinions differ widely. Lorenz,[38] Bradford,[39] and Gill[40] all regard it as unimportant, the first going so far as to say that its correction may lead to posterior subluxation. On the other hand, most writers are not prepared to disregard it, though they differ as to how, when, and where it should be corrected. Osteotomy is the usual method adopted, but Galleazzi[41] claims to correct it by plaster in inversion and active and passive exercises. Soutter and Lovett[42] say antetorsion improves with weight-bearing, especially after two or three years. Hibbs,[43] Calot,[44] and others do osteotomy in the lower third of the bone, while Froelich[45] snaps the atrophied femur over the edge of the plaster some months after reduction. Others divide the bone in the upper third. Schede[46] and Codivilla[47] use a nail driven into the trochanteric

region, to control the upper fragment.   As to the degree of antetorsion demand-
ing correction, Durham[48] operates on anything over 45°, while Werndorf[49]
puts the limit at 60°, and Bradford and Lovett[50] say 90° antetorsion is incom-
patible with normal gait and must be corrected.   Our experience is that if
hips are reduced·early, say before the fourth year, it is excessively rare to
meet with a case which demands osteotomy.   In the older cases, which should
become less and less numerous, a degree of antetorsion of real importance,
i.e., over 45°, is more common, but still rare.   Failure of the upper lip of the
acetabulum to grow out seems to me a far more potent factor leading to
re-dislocation than any deformity in the femur.

The next problem is : Should anything be done, and if so what, to the
adolescent or young adult with this deformity who suffers little or no discom-
fort, and never complains of real pain ?   In a previous paper[60] I produced
evidence to show how far from perfect were the anatomical results after
reduction in the older cases, even though the head of the femur, or what was
left of it, remained in the acetabulum.   Gross erosion from 'absorptive
arthritis' was present in most.   Further experience has not led me to alter
the opinion then expressed—namely, that it was more than doubtful
whether much good had been done ; in fact, it was probable that actual
harm had resulted, and that the grossly abnormal joint was even more likely
to give rise to pain, and this at an early age.

Hey Groves[51] has suggested leaving the capsule intact around the head,
separating it from the bone, and shifting it down to the acetabulum enlarged
sufficiently to receive it.   So far no detailed results in a series of cases treated
in this way have been published.   Though this ingenious method might be
useful in an occasional selected case over the age limit given above, I can
see no advantage in it over open reduction, coupled with a bone-grafting
operation to make an upper lip, when the femur can be brought down to the
requisite level.   Unless this last can be achieved with reasonable ease it is
better to leave the femur where it is.   This brings us to the question of the
bone-graft or bone-flap operation, first performed, according to Epstein,[52] by
Koenig in 1891.   The formation of an artificial lip to the acetabulum is a
most useful operation, and is being performed with ever-increasing frequency
by surgeons throughout the world.   It is sound from the anatomical point
of view.   The making of an efficient shelf is comparatively easy ; the difficulty
lies in making the shelf at precisely the right level.   When relapse is seen
to be occurring after manipulative reduction followed by prolonged fixation,
or when simple reduction offers but little hope of a cure—for example, in a
subluxated hip at 4 to 6 years of age, this operation is invaluable (*Figs. 225,
226*).   The procedure should always be added to open reduction when the
condition of the patient permits.[60]   Anterior transposition, or the shifting
forwards of the head towards the anterior inferior spine, by forcible manipu-
lation under an anæsthetic, is practised by many surgeons in irreducible cases.
By moving forward the point of support and increasing the range of extension
and abduction the gait may be greatly improved.   We have found this a
difficult thing to achieve, and moreover relapse may occur.   Lance suggests
it is best suited to young adolescents just too old for reduction.   Galeazzi[53]
and Loeffler[54] both prefer open transposition.   Adduction and flexion deformity

are, however, more satisfactorily corrected by osteotomy, at any rate in a unilateral case. The chance of arthritis in the future is not materially lessened by either of these operations, while in the former it may well be increased.

FIG. 225.—Unilateral congenital dislocation before operation. Age 5½ years.
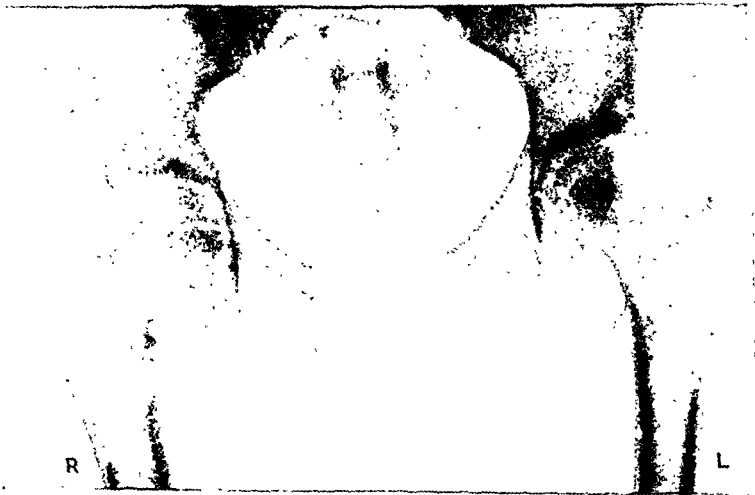
FIG. 226.—Case shown in *Fig. 225*, seven years after open operation for making an upper lip to the acetabulum.

Finally, we have to consider the difficult problem of the irreducible case which develops an increasing amount of disability and pain in adolescent or adult life. The difficulties are much increased when the deformity is bilateral, even though the symptoms be practically confined to one hip. It has already

been suggested that pain and greater disability may arise from muscle strain, but in all severe cases it probably results from arthritis. At the very least such cases must be regarded as potentially arthritic, and this must be taken into consideration in deciding what treatment to adopt. We have the following procedures to choose from : (1) Arthrodesis; (2) Osteotomy; (3) Shelf operation; (4) Excision of the head of the femur.

1. **Arthrodesis.**—This is unquestionably the operation which offers, if successful, not only the best but the sole hope of permanent relief, and in unilateral cases it would seem to deserve first place. An exception might be made in the case of an adolescent with a moderate amount of pain and little or no radiographic evidence of arthritis. In such à case osteotomy of some kind might be preferable. It would seem to be wisest, when arthrodesis is decided upon, and the displacement is more than a mere subluxation, not to try to bring the head down to the acetabulum, but to gouge out a socket between the true and false acetabula. A moderate amount of difficulty in getting the head into the hole thus made for it is highly desirable, to ensure close contact of the bony surfaces. In a recent case operated upon bone-grafts were utilized over the head, both to increase the chance of ankylosis and to provide a good shelf supposing the bones failed to unite. In a bilateral case arthrodesis of the hip giving the greater amount of pain may be the only possible procedure. Anything short of this would run the risk of throwing more strain on the painless or less painful side, with the inevitable result of increased arthritis and pain. The necessity of preventing adduction of the unoperated side calls for fixation of the arthrodesed hip in but slight, if any, abduction. In a middle-aged patient we may even be forced into attempting the fusion in an adducted position.

2. **Osteotomy.**—In 1925 Lance[55] published a most valuable paper on this subject, and in it he discusses the relative value of the various osteotomies that have been tried for these cases. The possible methods are shown in the series of diagrams taken from his paper (*Fig.* 227). His decision is against the bifurcation operation of Lorenz[56] and in favour of the simpler operation of Froelich, since if the former is successful and the end of the shaft really enters the acetabulum all movement is practically obliterated. It seems probable that after the lapse of a year or two all osteotomies performed at or just below the trochanteric region would look very much alike in a radiogram. After osteotomy, contact of the femur with the pelvis in all probability takes place over the retro-acetabular surface rather than opposite the socket itself. It is difficult to believe, however, that any of these osteotomies can do much to relieve the arthritis or the symptoms thereof. What is the anatomical result of a bifurcation or other type of osteotomy? If successful, the bent-in portion of the femur will take purchase against the pelvis, the weight being borne with the leg in the abducted position; but it is doubtful whether the femur really hitches in the acetabulum sufficiently to take much of the weight, or that it does this for more than a few months. If the operation is successful in the obtaining of a new point of support, it inevitably follows that movement must be limited, and this limitation in many cases seems to be considerable. Where does this movement take place? Either the femur hinges at the head, and the new 'articulation', if we may call it so,

allows forward and backward gliding movements, or the new articulation acts as the hinge and the head glides backwards and forwards, or gliding movements may take place at both. In any case some movement must take place at the head, and if arthritis is present, as we contend it is in most cases, is relief of pain to be expected? If movement is reduced to a minimum, I can understand considerable relief of pain being the result, but in that case is this operation any better than an arthrodesis except in so far as it is a much simpler procedure? There is, however, another possibility. When union has occurred after osteotomy and walking is commenced, the amount of abduction must tend to diminish, and if this takes place, the head of the bone will be levered outwards away from the ilium, the pressure between the
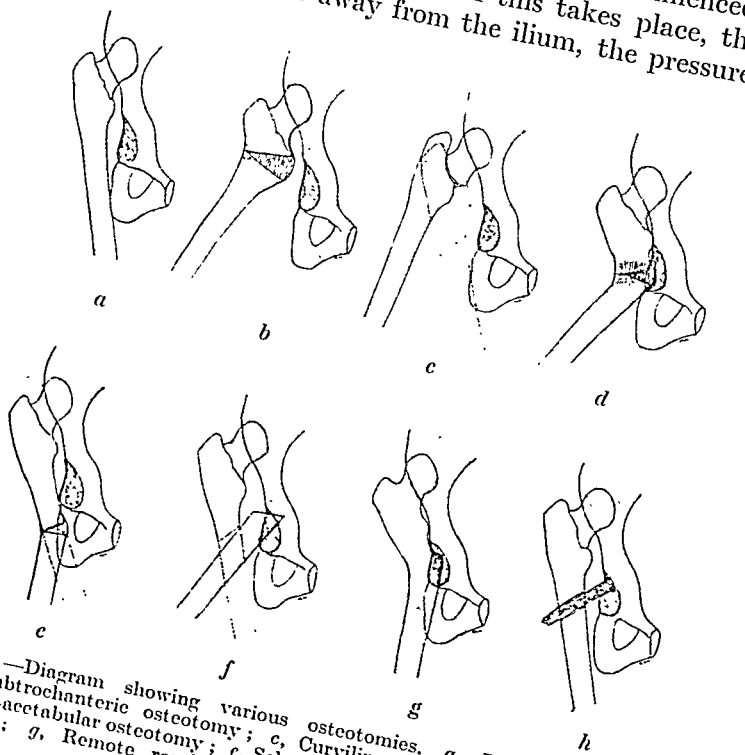
FIG. 227.—Diagram showing various osteotomies. a, Posterior dislocation; b, Kirmisson's subtrochanteric osteotomy; c, Curvilinear transtrochanteric osteotomy; d, Froelich's para-acetabular osteotomy; e, Schanz's ischiatic osteotomy; f, Lorenz's bifurca-tion operation; g, Remote result of Lorenz's operation; h, Maragliano's operation. (After Lance.)

two bones will be relieved, and thus the pain may be diminished or cured. As Girdlestone[57] points out in writing of pathological dislocation, the lower the osteotomy the greater the mechanical leverage that results.

Some of my friends are pleased with their results of the bifurcation operation in unilateral cases. Galeazzi, on the other hand, condemns osteo-tomy as mechanically unsound, and says the results of osteotomy that I regret There is so much difference of opinion on the value of osteotomy that I regret the more that my personal experience is insufficient to warrant a decision as to the value of this operation. So far as I can remember, only one case has been exhibited in London after a bifurcation operation, and this, a bilateral case, was not. I think, shown as a success. It would seem to me that

osteotomy is most likely to be successful, for a period of a few years at any rate, in cases a little over the age limit for reduction, whether performed to correct exceptional deformity or in the hope of relieving pain.

3. The Shelf Operation.—The so-called shelf operation for irreducible cases has been advocated strongly in recent years by Dickson, and to some extent by others.   Dickson[58] cuts the capsule freely away, applies mechanical traction, and endeavours to bring the head some way downwards as well as forwards, before turning down a shelf of bone above it.   If the head is already much damaged by arthritis, and this is certain to be the case where the patient is an adult and suffering much pain, can we expect the new joint to remain painless for long ?   However, Dickson is satisfied with his results, and gives details of one or two cases which were certainly greatly benefited by the operation.   So far as I know, he has made no further report since his original paper in 1924.   Mechanically this operation should increase the stability and improve the gait to a slight extent.   The stability might, I think, be improved by carrying the shelf in front of and particularly behind the head, and by shifting the trochanter forwards on the femur.   Although I have always doubted the soundness of this operation on theoretical grounds and have never performed it, I think there is one point definitely in its favour : even if it fails to give relief, or does so only for a time, it has prepared the way for a satisfactory arthrodesis.   In a bilateral case, when one side has been arthrodesed, it may be the only operation open to the surgeon.   Allison,[59] in a recent article, advocates the shelf operation as the best procedure in adult cases.

4. Excision of the Head of the Femur.—This operation unquestionably relieves the pain at once, and for so long as a weight-relieving caliper is worn afterwards.   When, however, the splint is discarded pain soon returns, while the limp is necessarily even worse than before.

To sum up : we feel that arthrodesis is unquestionably the best method and the only one likely to relieve the pain permanently, but that osteotomy is useful in a few selected cases.   The shelf operation, in the absence of any recent publication of the results in a series of cases, would seem to be still on probation.

SUMMARY.

In this paper I have endeavoured to call attention to the chief points of interest and importance in the anatomy of congenital dislocation of the hip.   In particular the changes in the bone behind the acetabulum, with the occasional formation of a facet at this spot, the arrangement of the capsule and the importance of the ischio-capsular band which forms a sling over the neck of the femur, have been pointed out.   The muscles which chiefly assist the capsule in slinging the pelvis on the femur are, I contend, the psoas in front and the obturators and their associates behind.   Factors which may contribute towards the production of the characteristic gait, and the causation of the pain experienced in later life, are discussed.   Finally, in a rapid survey of the treatment, the various operative procedures at our disposal have been criticized in the light of the foregoing facts and theories.

In these days of Child Welfare Centres, better diagnosis, and the ever-increasing practice of routine X-ray examinations, the number of cases of congenital dislocation left untreated till all hope of a cure is past is gradually diminishing. It cannot be insisted upon too strongly or too often that these cases must be sent to the surgeon early. Treated in early childhood the majority are cured by the manipulative method, and of the rest an ever-increasing number should be cured by open operation.

Is it too much to hope that the time will come, and that before many years, when every uncomplicated congenital hip will be cured at an early age, and the difficult problems presented by the irreducible case, hopelessly crippled on reaching adult life, will cease to trouble the surgeon?

The author wishes to record his great indebtedness to the Curator of the Musée Dupuytren in Paris for permission to make free use of the numerous invaluable specimens of congenital dislocation of the hip in that museum.

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SPONTANEOUS RUPTURE OF THE NORMAL SPLEEN.

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So contrary is it to the established conceptions of pathology, that there are many who doubt that a normal spleen can rupture spontaneously. There is every excuse for such an attitude; at the most there are but eleven recorded cases (Table I) of the condition, and the first of these was published in 1919.

Table I.—ANALYSIS OF CASES OF SPONTANEOUS RUPTURE OF THE NORMAL SPLEEN.

AUTHOR	SEX AND AGE	THE NATURE OF THE RUPTURE	RESULT	MICROSCOPICAL EXAMINATION
1. Shorten	M. 43	Tear in splenic pulp	Recovered	Normal spleen
2. Connors	M. 38	Subcapsular hæmatoma	Recovered*	Not done
3. Metcalfe and Fletcher	M. 21	?	Recovered	Normal spleen
4. Metcalfe and Fletcher	M. 21	Rent in convex surface	Recovered	Normal spleen
5. Skerritt	M. 53	Subcapsular hæmatoma	Died	Normal spleen
6. Atkinson	F. 35	Lower pole pulped	Died	Not done
7. Susman	M. 53	Subcapsular hæmatoma	Died	Not done
8. Rhame[1]	M. 23	Rent in convex surface	Recovered	Normal spleen
9. Remynse[2]	M. 16	?	Recovered	Normal spleen
10. Capecchi[3]	F. 27	Large rent in splenic pulp	Recovered	Not done
11. Girling Ball, reported by Underwood[4]	M. 50	Tear on anterior surface	Died	Apparently normal

* Died four years later from pulmonary tuberculosis. † Patient was four months pregnant.

In two of these eleven cases (Skerritt's and Atkinson's) the clinical notes are very briefly reported, and M. P. Susman,[5] from whose exhaustive study the above table is for the most part compiled, regards them as doubtful cases. This leaves us in possession of but nine authentic examples up to the present time.

The report of an additional case will help to consolidate the position of spontaneous rupture of the normal spleen as an established clinical entity.

CASE REPORT.

HISTORY.—On March 31, 1929. L. P., a male van driver, age 20, was seized with severe abdominal pain whilst sitting in a chair at home. Up to that time he had been perfectly healthy, except for a right-sided empyema in infancy. All his life had been passed in Birmingham. He is absolutely certain that he had not been involved in any accident or received any blow at work or play during the past year.

ON ADMISSION.—The patient was admitted to hospital eighteen hours after the commencement of the attack. He stated that the pain commenced in the umbilical

region and radiated to the right hypochondrium. Later the pain became more severe and radiated to the left shoulder, and for about ten hours persisted in the left shoulder as well as the whole of the abdomen.

ON EXAMINATION.—The temperature was 101° and the pulse 100. The abdomen moved normally with respiration. There was some general tenderness, maximal in the right hypochondrium, where rigidity was also located. On the left side there was a mal-descended testis within a hernial sac. This was tender, and the sac contained fluid opaque to transillumination. I went to some pains to exclude the possibility of torsion of the testis with hæmatocele. A definite diagnosis could not be made, and the patient went to the operating theatre as a case of ? perforated duodenal ulcer, ? appendicitis.

OPERATION.—Anæsthesia was induced by injecting 0·7 c.c. of stovaine intrathecally. A small gridiron incision was made. On opening the peritoneum pure blood escaped profusely, and it was then that the probability of spontaneous rupture of the spleen crossed my mind. The gridiron incision was closed. At this stage the

FIG. 228.—The patient six weeks after operation, showing the mid-line incision used for splenectomy.

anæsthetic was supplemented by a little gas and oxygen. A mid-line incision was made in the epigastrium, and on opening the peritoneum blood again poured out. The hand was passed into the left hypochondrium ; clots of blood floated up into the wound ; the spleen felt large, and left little doubt that the source of the hæmorrhage had been found. Splenectomy was performed. Handfuls of clots were removed from the left upper abdomen, but no attempt was made to engage upon the Sisyphean task of mopping up the fluid blood. The abdomen was closed, the operation being completed in under half an hour. Subcutaneous saline was administered at the close of the operation and continued after the patient had been returned to bed. There were no post-operative complications, and the patient is in normal health at the present time (Fig. 228).

The excised spleen is shown in Figs. 229, 230. The photographs clearly demonstrate a subcapsular hæmatoma which has burst. The histological examination (Fig. 231) of the organ was undertaken by Dr. Whitelaw, and he

reports that the structure is that of a normal spleen. Serial blood-counts were carried out by Miss Trought, B.Sc., and the findings conform with those of traumatic rupture of the spleen.
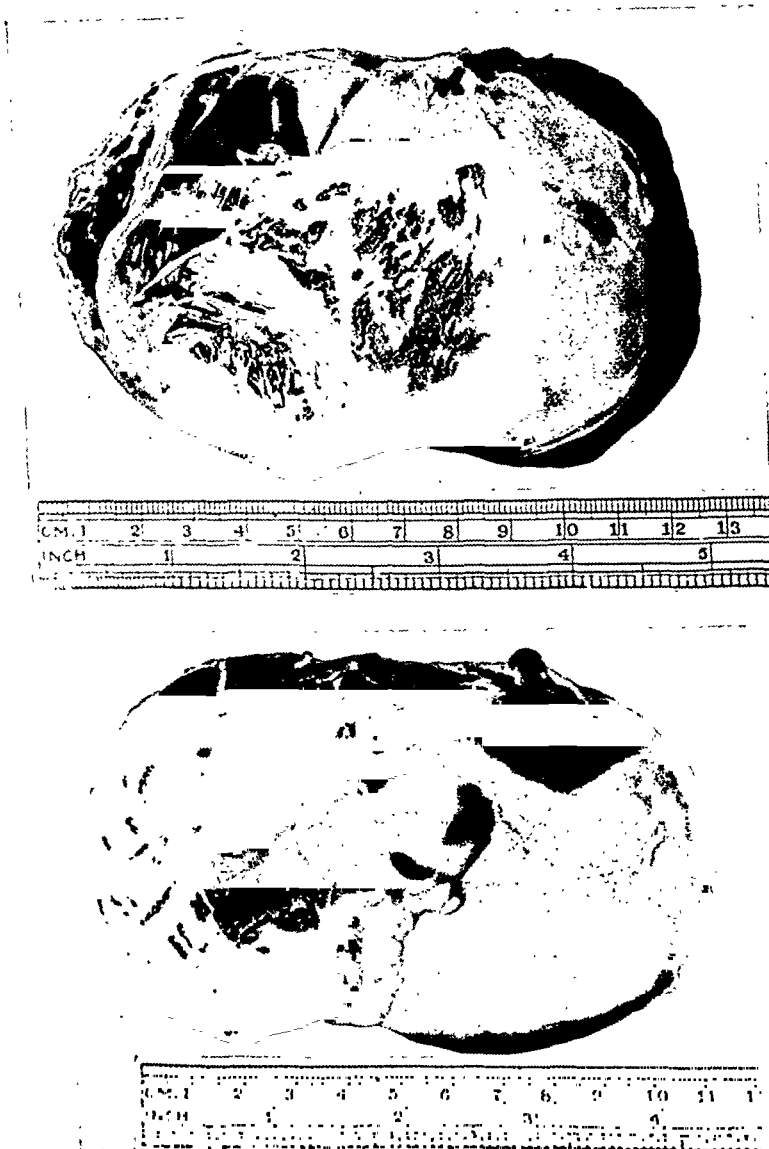
FIGS. 229, 230.—Spontaneous rupture of the normal spleen. The subcapsular hæmatoma which burst is well shown.

ETIOLOGY.

There are on record at least three examples[6,7,8] where, after successful splenectomy for supposedly *spontaneous* rupture, the investigator has been able to elicit the history of a blow. On the other hand, no such history was obtainable in my case, or in any of the cases included in the foregoing table.

An accident of sufficient magnitude[9] to rupture a normal spleen is unlikely to be forgotten by the recipient. To assume that all the patients whose spleen is alleged to have ruptured spontaneously had forgotten such an accident, or alternatively, had deliberately withheld information concerning it, seems impossible. Yet how else are we to account for the bursting asunder of a normal spleen ? If the theory of an overlooked accident is discarded, we are plunged into a morass of speculation in which (on account of the great rarity of the condition) it is unprofitable to linger.

Only the spleen can behave in this curious manner, and from the practical standpoint there follows a good aphorism : " *In atraumatic hæmoperitoneum in the male examine first the spleen.*"
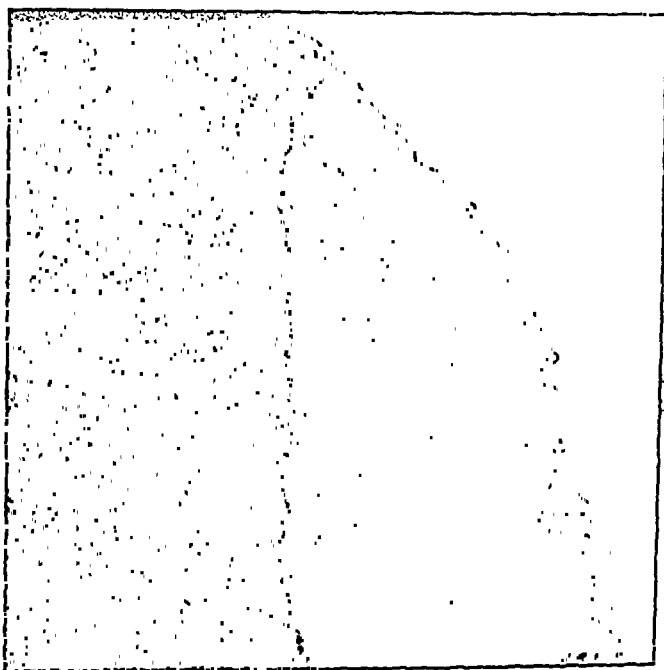
Fig. 231.—Section of the spleen, showing the subcapsular hæmatoma. (× 25.)

SPONTANEOUS RUPTURE OF THE SPLENIC VEIN.

On the clinical side spontaneous rupture of the splenic vein bears comparison with spontaneous rupture of the spleen ; pathologically the conditions are widely separated. The bursting of an engorged vein can be readily understood. In the only two examples which are available in the recent literature the liver was diseased, and as a consequence the venous pressure in the radicles of the portal vein would be increased.

Ogilvie's[10] patient was a clerk, age 31. who gave a history extending over eight years of attacks of jaundice. He was admitted into Guy's Hospital with an enlarged liver and spleen, and whilst in hospital suddenly presented grave acute abdominal symptoms. Laparotomy revealed a hæmoperitoneum.

and renewed hæmorrhage was controlled only after the splenic pedicle had been clamped. Splenectomy and autotransfusion failed to save the patient's life. Necropsy showed a malignant hepatoma with secondary deposits in the lung.

Pyrah, Stansfield, and Garland[11] have furnished another example.. The patient was a woman of 38 who died six hours after the onset of acute abdominal pain. At necropsy the peritoneum was found full of blood, the source of the hæmorrhage being a tiny hole in the dilated splenic vein. There was well-marked multilobular cirrhosis.

CONCLUSIONS.

1. A case of spontaneous rupture of the normal spleen is recorded.

2. Kehr's sign of left shoulder pain in ruptured spleen was well marked, although its diagnostic significance was not appreciated.

3. Yet another example of hæmoperitoneum with a comparatively slow pulse-rate is brought to notice

4. Additional evidence is afforded that the mid-line upper abdominal incision is adequate for splenectomy in cases of rupture.

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A PLASTIC OPERATION FOR FACIAL PARALYSIS.

BY W. O. LODGE,

HON. OPHTHALMIC AND AURAL SURGEON TO THE ROYAL HALIFAX INFIRMARY.

So far as one can judge from a solitary case, the procedure described below is worthy of more extended trial. It is designed to ameliorate disfigurement and to ward off impending corneal ulceration in long-standing cases of lower-neuron facial paralysis, more especially those due to mastoid disease, or accidentally inflicted during mastoid operations. Suitable cases are rare.

Without leaving conspicuous scars, three new ligaments are grafted into the face, corresponding in position to the inferior portion of the orbicularis oculi, the levator palpebræ superioris alæque nasi, and the zygomaticus major.
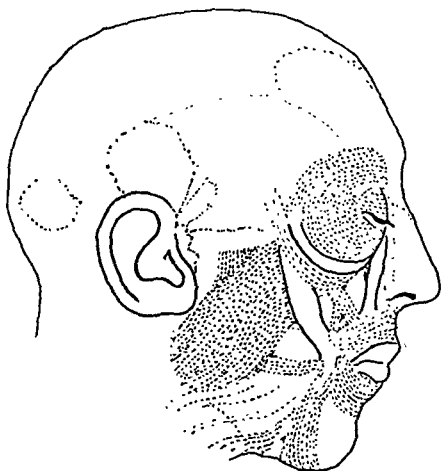
FIG. 232.—The muscles of expression.
(*After Cunningham.*)

FIG. 233.—Showing the strip of fascia lata *in situ.*

(*Figs.* 232, 233.) These sustain the drooping lower eyelid and palsied side of the mouth, and make them conform to a more pleasing facial expression. The material employed is a continuous strip of fascia lata. General anæsthesia is induced, and a 2 per cent solution of mercurochrome is applied freely and widely to disinfect the skin, conjunctiva, and buccal surface of the cheek. A probe is passed along the inferior lachrymal canaliculus, to define its position. The angular vein and parotid duct must also be avoided.

Two short incisions are made, exposing the temporal fascia and the internal palpebral ligament respectively. The latter structure—a familiar

landmark in the operation of excision of the lachrymal sac—is invariably well defined. A third tiny incision is made at the junction of skin and mucous membrane at the angle of the mouth. Meanwhile an assistant has been excising as long a strip of fascia lata as can possibly be obtained, 5 mm. in width, from the outer aspect of the thigh ; this is threaded along a triangular course between the three facial incisions, among the atrophied muscles, with the aid of a packing needle. The internal palpebral ligament and orbicularis oris are encircled en route. The two free ends are drawn taut, and woven into the fibres of the temporal fascia. The incisions are closed and the tension is temporarily relieved with adhesive strapping.

The result is not so good as is obtainable in cases of shorter duration by facio-hypoglossal anastomosis, but the method has one real advantage—its effect is immediate.

TOXIC GOITRE.

By T. P. DUNHILL, C.M.G.,

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ETIOLOGY.

A REASONED plan for the place that surgical procedure should occupy in the treatment of toxic goitre can only be made when the evolution of the disease is understood. There is not universal agreement on this point, but I believe that, apart from the inflammations and malignancy, thyroid diseases are linked together. The work embodied in this paper has been carried out in a clinical unit, and no claim is made to interpret difficult pathology. The difficulties of the interpretation of clinical conditions by examination of the pathological material are very great. Able pathologists are spending their whole lives at this problem ; Marine, Scott Williamson, Pearse, and many European investigators have done invaluable work. The difficulties of the problem are shown by the statement by Marine,[1] who has spent more than twenty years at work on thyroid pathology, that he has found it vain to use human thyroids (whether obtained at surgical operation or autopsy) as his starting-point ; while Scott Williamson and Pearse,[2] after stating some of the difficulties, write : " We would deprecate any attempt to solve these by reference to the clinical condition of the patient ; that is indeed the source of all confusion in pathological studies." These statements should scarcely be quoted apart from their context, but we have inquiring minds, and we have to treat people who are ill, and we have to teach students who have inquiring minds. I therefore cannot agree that the clinical condition of the patient should be ignored, and only the histopathological appearances used in the grouping of goitres.

Difference in the Types of the Disease.—The differences which may occur in the manifestations of toxic goitre in different patients have been noted by all observers, and much ingenuity has been shown in accounting for them. These are so obvious as to suggest two diseases, one being called 'exophthalmic goitre' (*Fig.* 234), the other 'toxic adenoma' (*Fig.* 235). Not only are the manifestations in characteristic instances of the two types strikingly different, but the two types tend to occur at different periods of life ; the so-called exophthalmic goitre, with its staring eyes, pronounced nervous symptoms, rapid but usually regular heart rhythm, being most common in early adult life. On the other hand, the so-called toxic adenoma is rarely associated with exophthalmos, the nervous symptoms are comparatively mild, but the heart rhythm becomes irregular, congestive heart failure is not uncommon, and this syndrome tends to occur about the period of life usually associated with the menopause—on an average two decades later than the onset of primary exophthalmic goitre.

There are, however, facts—I use the word 'facts' advisedly—which have always troubled some of us. We have tried to force cases into a type, and it has left us with an uneasy feeling from time to time that a case would not

FIG. 234.—Primary toxic goitre ('ex-ophthalmic goitre').

FIG. 235.—Toxic goitre ('toxic adenoma'): no exophthalmos, auricular fibrillation of nineteen months' duration.

FIG. 236.—Primary toxic goitre with no eye signs.

FIG. 237.—Bilaterally symmetrical goitre ('toxic adenoma'): no eye signs, auricular fibrillation.

fit in, notwithstanding that many did so readily. As examples, there are patients of the so-called exophthalmic type without exophthalmos (*Fig.* 236), and of the so-called toxic adenoma type with no obvious adenoma, but with

a diffuse goitre (*Fig.* 237).

FIG. 238.—'Toxic adenoma': one single nodule, the remainder of the gland apparently normal.

The eye signs vary in degree. There may be extreme proptosis, or the slight but unmistakable lift of the eyelids without proptosis, or there may be no eye sign present. Again, in the so-called toxic adenoma group, in a typical example there is present a single adenoma (*Fig.* 238); but another with similar symptoms will have an irregular adenomatous mass (*Fig.* 239), a nodular goitre more or less bilateral, or a bilaterally symmetrical goitre in which the irregularities of surface are so slight that it feels almost smooth (*Fig* 240).

FIG. 239.—'Toxic adenoma': auricular fibrillation; an irregularly shaped unilateral mass.
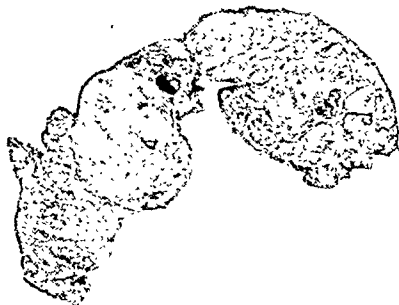
FIG. 240.—'Toxic adenoma': auricular fibrillation, no exophthalmos; bilateral enlargement, almost smooth.

One Single Disease.—Lengthening experience, with observation of patients suffering from toxic goitre, followed by operations upon them, examination of pathological material removed, together with the later histories, have compelled me to believe that these patients do not belong to two distinct groups; and that the difference, striking though it may be in extreme cases, is of degree only and not of kind. My belief now is that a full range of cases exists representing every stage between exophthalmic goitre at one end and toxic adenoma at the other, and that we can observe in a graded series of patients exophthalmos and central nervous system symptoms becoming less and less until they almost or entirely disappear. Corresponding with this we can observe the thyroid gland become less smooth and symmetrical, and become more nodular. until we reach a gland with a single adenomatous mass (*Fig.* 241).

These transitional forms are not so few in number that they may be ignored; they are as numerous as those of the so-called exophthalmic or toxic adenoma type. I believe that we are dealing with one disease whose manifestations differ under differing conditions. and that these conditions depend upon factors some of which are well-defined and some of which are not yet clear, and that these factors are three. I propose to examine each, and to show the response to surgical treatment in some groups of cases in which the patients have reached an extreme degree of disability. and the reasons why

the response to surgical treatment is conditioned by the three etiological factors.

Nomenclature.—Parry described the disease accurately in 1786, Graves in 1836, and Basedow in 1840. I shall employ the words 'toxic goitre' to replace these names* and also the terms exophthalmic goitre and toxic adenoma, because the only two facts about which there can be no argument are, first, that there is a goitre, and, secondly, that there are evidences of toxicity referable to the goitre. The word 'hyperthyroidism'—that is, excess of normal secretion[3]—which occurs so constantly in the literature, may, or may not, express the condition present in some patients. With the evidence
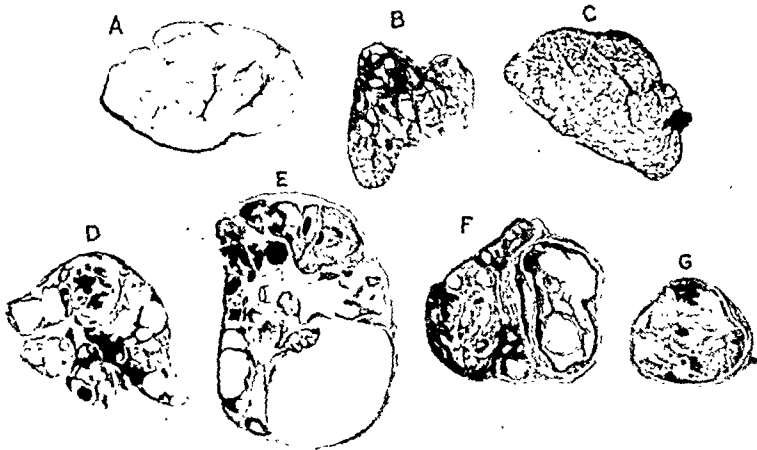
Fig. 241.—A series of *specimens removed at operation*, showing the gradation from primary toxic goitre (exophthalmic type) to secondary toxic goitre with a single nodule (toxic adenoma type).

A, Primary toxic goitre—bilateral, smooth (exophthalmic type). B, Secondary toxic goitre — early type — exophthalmos—bilateral—smooth—scattered areas of hyperplasia. C, Secondary toxic goitre—early type—exophthalmos—bilateral—smooth—no solid areas visible to the naked eye—appears completely colloid. (Patient, *Fig.* 256; sections, *Figs.* 252, 253, 254. D, Secondary toxic goitre—later type—bilateral, becoming nodular to palpation—no exophthalmos—auricular fibrillation for four years. E, Secondary toxic goitre—unilateral—very big, irregular masses—auricular fibrillation eight years—œdema extensive. F, Similar to E, but smaller and smoother. G, Secondary toxic goitre—one single smooth nodule—typical 'toxic adenoma' type.

at present available I emphatically believe that it does not, and that the disease throughout its whole range is a toxic state. Some qualifications of the term 'toxic goitre' will be necessary, but these qualifications need be only of the simplest, and employed in order to indicate whether the disease is a primary or a secondary condition, and whether, if secondary, the condition is an early or a late one. A 'secondary' condition implies that the thyroid

* The term 'exophthalmic goitre' is so descriptive, and both it and the name 'Graves' disease' are so firmly established, that they will certainly remain permanently; although if the disease is to be associated with the name of an individual, should it not be that of Parry ?

gland has been the seat of a non-toxic goitre before toxic manifestations occurred. Throughout the literature of toxic goitre there has been much argument as to whether the disease is essentially of the thyroid gland[4] or whether the gland changes are part of a general disorder. Let me say at once that I believe that the stimuli which bring about the disease are situate without the gland, and that these stimuli affect the gland, causing such change in its structure and function that its secretion is altered, and consequently other organs are intoxicated by its altered secretion. The enlarged thyroid itself, together with the intoxication of the other organs, give us the manifestations of the disease.

Three Primary Factors. — We have therefore three factors present: (1) The stimuli; (2) The thyroid gland; (3) The organs affected by the disordered secretion.

The First Factor: the Stimuli.—A normal thyroid gland functions in response to normal stimuli in a properly balanced body. We have some evidence that normal stimuli can become excessive and therefore abnormal, and that these abnormal stimuli affect the thyroid gland detrimentally.

The Second Factor: the Gland.—An individual may have a gland which is normal; or a gland which has already become a colloid goitre, or which by successive waves of stimulation has passed through stages of hyperplasia and involution and become a nodular goitre; or an otherwise normal gland may contain an adenoma. These changes are frequently occurring apart from toxicity or before any question of toxicity arises; and on to a gland in any one of these states, or any combination of these states, there may be directed the pathological stimuli which constitute the first factor. The reaction of the thyroid gland to these stimuli must vary within limits according to the amount and condition of its own epithelial elements at the time.

The Third Factor: the Cells of the Body.—Plummer has well said that the energy output of the cells of the body is determined by the secretion of the thyroid gland. So sensitive are these cells to the amount and quality of thyroid secretion, that differences in the amount or quality produce results that are obvious, and whose nature is becoming increasingly well known to us. For the purpose of this discussion, instead of taking the cells of the body generally, I am confining myself chiefly to the muscle fibres of the heart, for the reason that the heart is an organ influenced by thyroid secretion in a manner that can be observed, and to a great extent measured. This third factor of the heart before it is affected may also vary within wide limits.

My thesis is that the variations in these three factors and their inter-relationships give a sufficient explanation of the different types of toxic goitre —why in youth and early adult life we have the picture described as exophthalmic goitre; why this type becomes less frequent with succeeding decades, although it never completely disappears; and why the type described as toxic adenoma rarely occurs in early adult life but becomes the increasingly predominant type in the later decades. Let us take the three factors in more detail.

1. FIRST FACTOR: THE STIMULI.

The origin of the abnormal stimuli that affect the thyroid gland has troubled the clinician since the earliest recognition of the disease, and still there is little certain evidence. We have elicited some facts; some things we can only suspect. Let us first take the facts :—

1. The gland contains iodine, and the administration of iodine can affect its histopathology and physiology. In the disease we are discussing, its administration can cause a striking change in the clinical picture. Iodine undoubtedly has a profound influence on the gland.[5-8]

2. Marine[9] showed years ago that a goitre could be produced in fish at will, and more recently McCarrison[10] has been able, by feeding experiments with deficiency of manganese, to create the histological picture of a pathological gland in approximately 25 per cent of cases (*Fig. 242*).
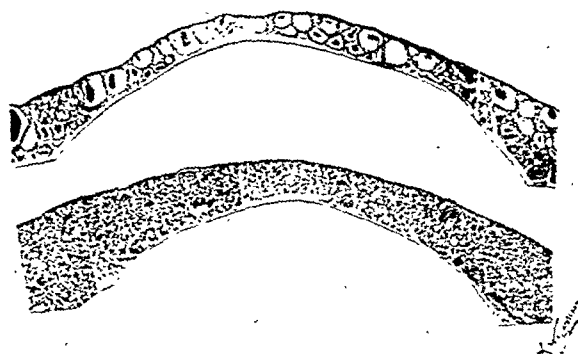
FIG. 242.—Experimentally produced lymphadenoid goitre in rat. Upper figure, normal isthmus; lower figure, goitrous isthmus. (*McCarrison.*)

3. Rupert Farrant[11] began to show, and Cole and Womach[12] have demonstrated, that acute infections quickly affect the histology of the gland. Add to this that an acute infection, such as tonsillitis, occurring in the course of the disease immediately sends up the pulse-rate and obviously increases the gravity of the other symptoms. I have seen a gain in weight of two stones follow the enucleation of infected tonsils during the course of the disease, and amelioration of the symptoms has repeatedly followed this procedure.

4. It is common knowledge that in some women visible enlargement of the gland occurs at the periods of physiological activity of the reproductive organs. We cannot doubt that an intimate relationship exists between the reproductive organs and the gland.

5. We know how psychic states can affect the disease. I have seen unhappy family life cause repeated exacerbations, finally ending in death, in a young person, and we have all seen the improvement that follows physical and mental rest.

Now we leave what we know, and consider what we can only suspect. What Marine and McCarrison achieve experimentally may be happening to anyone, and is certainly happening to some through unconscious diet deficiencies. There may be deficient intake of iodine or manganese, or indeed of other necessities which we know not of; or, even if there is an adequate intake, part of this may be deflected from its normal course and used up in such ways that sufficient never becomes available for the thyroid. Marine and McCarrison have not shown that the experimentally produced change in the histopathology of the gland is ever associated with thyrotoxicosis, but a gland such as they show has ceased to be a normal gland. Also there are added from time to time infections. The evidence is clear that these further damage the gland, and in some few these damages through lack of chemical balance, and through infections, may hinder the gland from standing up to subsequent strains. For in this world the subsequent stresses and strains come, and, in relation to this disease, two types of them are predominant: the psychic and the sexual. Normal cerebral balance becomes disturbed by what may be called psychic trauma—the mental distresses suffered by sensitive people; the mental conflict constantly undergone even by some who are not unduly sensitive, through the disorganization of the affections or business or health. Let me instance a girl of 18 who was compelled to live with an uncle who was very difficult. She lived in great unhappiness, and had no rest except when in hospital. We watched her through several exacerbations of the disease, and in one of these she died. These cases could be multiplied, but it is not necessary. Now consider sexual troubles. We have noted that sometimes the thyroid gland alters in size with menstrual periods. The development and control of sexual balance 'is not perfect in all of us. Our American colleagues have coined a suitable phrase—'sexual imbalance'. With some this may be absent, development and control going on perfectly and almost subconsciously. With others it is otherwise. In some it is a question of thwarted affection. I have seen young women in whom I am compelled to believe that the disease started when the parents continued to forbid an engagement. In others the difficulty is sexual urge. A surprising proportion of the men who have suffered from this disease have voluntarily told me of their mental turmoil. They live in an atmosphere of sexual introspection, and do not appear to obtain peace. I have never felt it wise to probe into these affairs, because I know of no remedy for our inherited desires.

I cannot tell you that these are the causes of Graves' disease.* Most people go through all these troubles without falling victims to the disease, but I have found one or another of them looming largely in most patients. The point I want to bring out at the moment is not the ultimate cause, but the incidence of the factors at the different periods of life. The food and chemical factor is present throughout life. Infections are always with us. The physiological stresses and the passions are strongest in the early years of adult life. The cerebral cortex reacts to them more intensely, and their effects are felt more keenly at this period. May this not be the reason why

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* The disease does occur in early childhood. It is difficult to explain the origin of the pathological stimuli at this age.

primary Graves' disease is much more frequent in the earlier decades of life? (This point will be referred to again when discussing the variations in the 'second factor'—the thyroid gland). Do these passions cease with age? Not at all, but much of their intensity lessens. Business and family worries may be great. Even sexually we are told that there is a dangerous age, but fortunately more tranquillity, even calculation, comes with advancing years. For these reasons, primary Graves' disease can begin in the later decades of life, but in these later decades the primary disease is less frequent. When the primary disease does occur in later life it is, for reasons which will be given later, a much more serious condition.

2. SECOND FACTOR: THE THYROID GLAND.

Most people commence life with a normal thyroid (Fig. 243), but a diffuse colloid goitre may occur early in life (Fig. 244). This, as de Quervain[13] and others have shown, gradually begins to change into a nodular goitre about
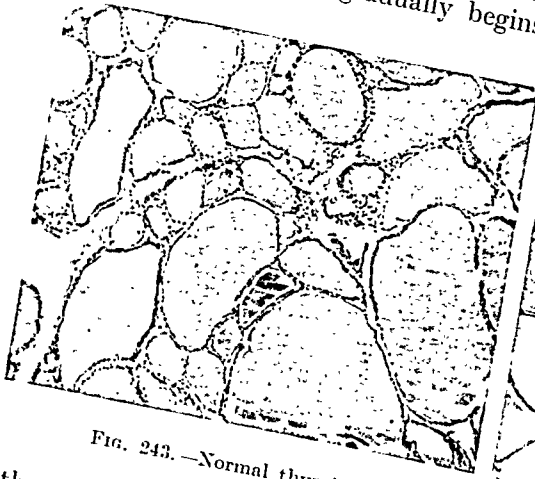
FIG. 243.—Normal thyroid.
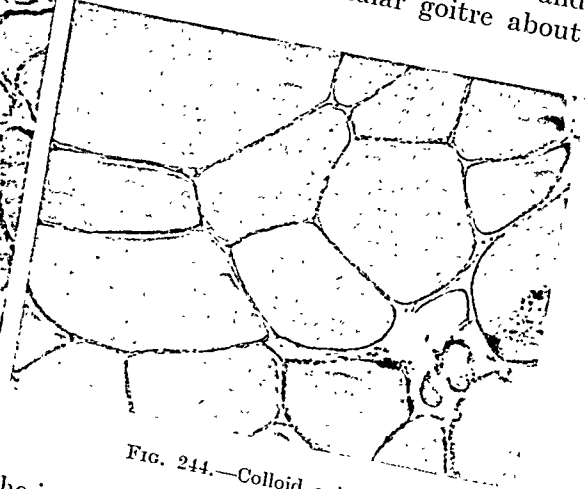
FIG. 244.—Colloid goitre.

the third decade (Fig. 245). Through the increase in the fibrosis, and localized hyperplasia followed by involution, this ultimately may become fibrocystic. Rienhoff and Dean Lewis[14] have elaborated this, showing further the development of colloid adenomas (Fig. 246).
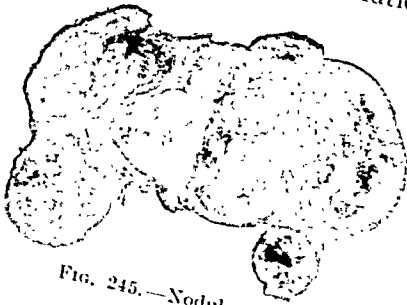
FIG. 245.—Nodular goitre.
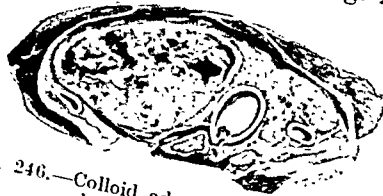
FIG. 246.—Colloid adenoma from a specimen obtained post mortem.

Again, a fœtal adenoma can exist in an otherwise normal thyroid gland. A gland in any one of these conditions may come under the influence of the

pathological stimuli which I have indicated as probably constituting the 'first factor' in the production of toxic goitre. The earlier in adult life this occurs, the more normal the thyroid epithelium will be ; the later in life it occurs, the more likely is the gland epithelium and reticulum to have been affected already by waves of activity and involution. The gland may be in some stage of exhaustion. It is obvious that the histology of the thyroid gland, apart from any question of toxic-ity, may vary within wide limits. Its reaction to pathological stimu-
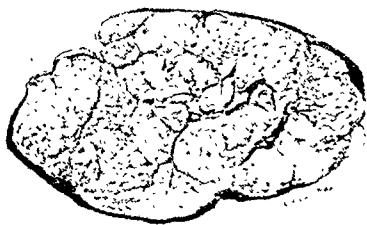
FIG. 247.—Primary toxic goitre (exophthalmic type) : macroscopic.
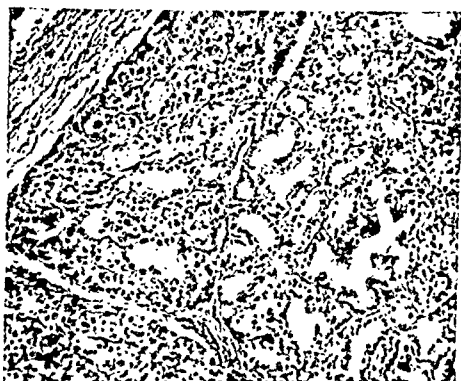
FIG. 248.—The same gland as shown in *Fig.* 247: microscopic.

lation must depend on its own condition when the stimulation begins to affect it. If the gland is a normal one, the whole gland can respond, and we see the picture which I have hitherto called a 'primary exophthalmic goitre' (*Figs.* 247, 248); which Scott Williamson and Pearse[2] have called an 'adenoid goitre'; which Wilson, Marine, Rienhoff, Dean Lewis, and many others have described, and

FIG. 249.—Secondary toxic goitre— early (exophthalmic) : scattered areas of hyperplasia.

FIG. 250.—Secondary toxic goitre—early. apparently all colloid, exophthalmos. (Cf. *Figs.* 252, 253, 254, 256 from the same patient.)

which I now wish to call 'primary toxic goitre', or 'primary Graves' disease', or 'primary Basedow's disease'. If a thyroid gland is already in a state of colloid goitre when first affected by the stimuli constituting the first factor, its epithelium is already to some extent exhausted, and to some extent

destroyed. There is less of it, and what remains is incapable of reacting to the same extent as the normal gland could. Therefore we do not see the solid non-colloid gland which has been called primary exophthalmic goitre, yet the epithelium of the colloid goitre reacts to the stimulus to the extent to which it is able. But the macroscopic appearance will vary greatly; first according to whether the toxic change comes early or late after the occurrence of the colloid goitre, but also among patients at the same stages. There are
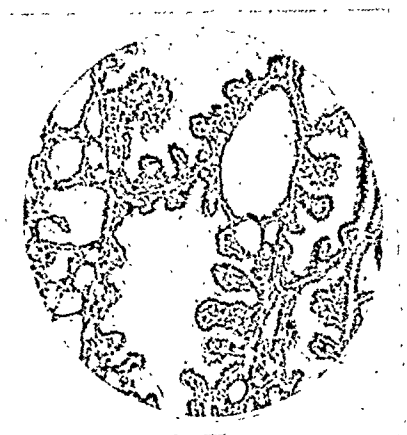
FIG. 251.—Secondary toxic goitre—exophthalmos. Lace-like type.
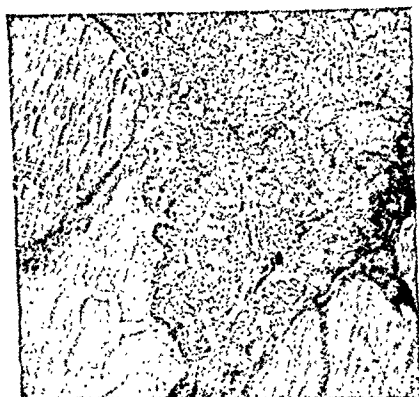
FIG. 252.—Secondary toxic goitre—early. Exophthalmos. Almost the whole gland consisted of large colloid vesicles with small scattered areas of hyperplasia. (Cf. *Figs*. 250, 253, 254, 256 from the same patient.)
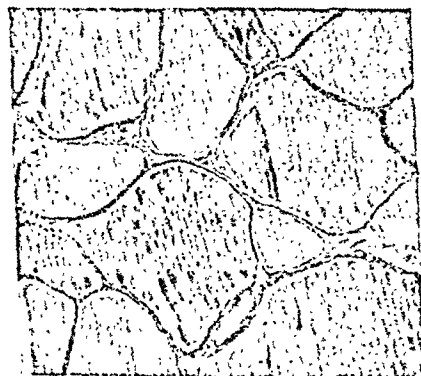
FIG. 253.—From the same patient as shown in *Figs*. 250, 252, 254, 256.

FIG. 254.—From the same patient as shown in *Figs*. 250, 252, 253, 256.

sometimes scattered solid areas of hyperplasia readily visible to the naked eye (*Fig*. 249). *Fig*. 250 shows one in which the whole gland appears to be still completely colloid, with no solid areas visible to the naked eye. Or the hyperplasia may be universal in the epithelium lining the vesicles—the type described as 'lace-like' by Rienhoff and Dean Lewis (*Fig*. 251).

Fig. 252 shows areas of hyperplasia in juxtaposition with large colloid vesicles. This is better shown in *Figs*. 253, 254, which are taken from different

parts of the same gland. These three sections are taken from the case shown in *Figs.* 250 and 256. They show how diverse the pathological picture may be. Occurring in young women, the clinical picture is scarcely distinguishable from that of the primary disease (*Figs.* 255, 256). This is because the stimulus is strong, and the thyroid epithelium is active enough to react to it. Why then call these other than primary Graves' (or Basedow's) disease ? Because the history and the pathological examination show them to be secondary, and because they constitute the first link in the connecting chain between exophthalmic goitre and toxic adenoma. The second link occurs when a non-toxic colloid goitre has become nodular before it is affected

FIG. 255.—Early secondary toxic goitre : exophthalmic type.

FIG. 256.—Early secondary toxic goitre : exophthalmic type. The greater part of this gland appeared to be colloid goitre. (Cf. *Figs.* 250, 252, 253, 254.)

by the pathological stimulus. The diffuse, colloid, non-toxic goitre of the earlier decades evolves into the diffuse nodular goitre of the later decades, because hyperplasia becomes localized on account of the inevitable fibrosis. Hyperplasia, involution with colloid storage, colloid degeneration, and fibrosis may all go on together in different parts of the same gland (*see Fig.* 245). De Quervain,[13] Scott Williamson and Pearse,[2] Rienhoff and Dean Lewis,[14] and others have described the transitional changes. At any time during these stages the gland may be affected by the pathological stimuli which we have called the 'first factor'; but two points must be noted : Firstly, by the fourth decade (and a colloid goitre rarely becomes nodular before the beginning of the fourth decade) the pathological stimuli are much less intense, for the reasons I have previously stated, and there is much less thyroid epithelium capable of responding to the stimulus; also, what epithelium there is, is less active. The stimulus is less, and the reaction to the stimulus is less. Therefore exophthalmos and the symptoms due to the central nervous system tend

to be less, and often are absent, so much so that the disease at this stage has been described as a different disease—a toxic adenoma. The cardiovascular signs and symptoms predominate, for reasons that will be stated later. Allen Graham[15] and Rienhoff[14] have each described the evolution of the single nodule toxic goitre (*Fig* 257).

It will be realized how great the variation in the 'second factor'—the thyroid gland—may be. It may be normal gland, colloid goitre, diffuse or unilateral nodular goitre ; it may contain a colloid or a fœtal adenoma ; it may be in any of these conditions, or in any transitional stage, when it is first affected by the ' first factor', the pathological stimuli. These two stages, the early and the late secondary toxic type, completely link the so-called exophthalmic goitre with the so-called toxic adenoma.
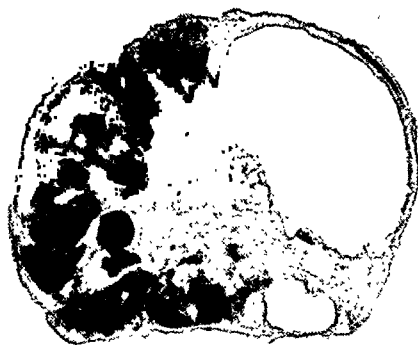
FIG. 257.—Late secondary toxic goitre, unilateral : toxic adenoma type.

3. THIRD FACTOR: THE BODY CELLS.

As the example of the 'third factor' I take the muscle fibres of the heart. The reasons for this are that these cells are peculiarly sensitive to qualitative or quantitative changes in the thyroid secretion ; that the manifestations are such that every clinician is familiar with them ; that they progress from simple tachycardia to arrhythmia ; that to a great extent they are subject to measurement ; and that just as they progressively increase with the intensity of thyroid toxæmia, so return towards normal occurs with reduction in thyroid toxæmia. The young adult heart has great reserve power. Most individuals up to adult life and early middle age possess a heart with sound musculature, but by the fifth and sixth decades work, modern play, possibly child-bearing, influenza or other infective attacks, and age itself, have each contributed to the wear and tear of muscle fibre. The fact that mountain climbing, boat racing, deer stalking, and similar sports entailing heart strain have to be given up in middle age, drives home to us the fact that heart muscle can stand less than it could in youth and early adult life.

Importance of the Variation in the 'Third Factor' (the Quality of the Heart Muscle).—We have considered how the 'first factor'—the pathological stimuli—may vary within the widest limits; how the 'second factor'—the thyroid gland—may also vary within wide limits ; how the 'third factor'— the body cells, of which at the moment we take as an example the muscle fibres of the heart—varies within equally wide limits before the impact of the altered thyroid secretion affects it. This altered secretion may be of high toxicity, but if the cardiac neuromuscular mechanism is young and unimpaired, tachycardia alone results, and, although this may be severe, the rhythm remains regular until, at long last, the reserve is broken down. If the heart muscle is older when the impact comes ; if it is fourth, fifth, or sixth decade muscle : if, in addition, it has undergone the vicissitudes of

work, strenuous play, and, perchance, illnesses, life will have levied tóll of its reserve, a slight degree of thyroid toxicity will break down its reserve, and irregularity of rhythm occurs early. If we look at the end-result we would say : " A very severe grade of intoxication." Not so : it may be a very slight grade of intoxication. The end-result is conditioned by the quality of the body cells on to which the intoxication is directed. The slighter degree of toxicity is the explanation of the infrequency with which eye phenomena occur — or the slighter degree to which they occur—in late secondary toxic goitre. In this late toxic goitre the 'first factor'—the pathological stimulus—is generally slight by comparison with its intensity in youth. It is directed on to a thyroid gland of which the parenchyma has been subject to involutional changes, the 'second factor' is at its minimum importance, and the resulting toxicity is therefore slight, so slight that it does not affect the eyes, and scarcely the central nervous system ; but the worn heart muscle with its reserve used up fails, and fibrillation occurs. The minimum effect on the eyes and the central nervous system, and the maximum effect on the heart mechanism, does not imply a different disease ; it is simply a difference in the ratio of the three factors.

Nothing that I have said precludes the possibility of a primary toxic goitre occurring in late middle age. A stimulus of sufficient intensity, and thyroid epithelium free from involutional changes (both of which are less usual in late middle life), can and does produce it, but it occurs less frequently with advancing years (*Fig.* 258). In a case of proposed operation a sharp distinction must be drawn between fibrillation occurring in late secondary toxic goitre and fibrillation in an elderly person

FIG. 258 —Primary toxic goitre in an elderly person.

with primary toxic goitre. There is a great difference in the surgical risk.

We seek for truth. We have not yet found it. There is much to perplex us. Not infrequently the removal of a single nodule, leaving the remainder of the thyroid *in situ*, has resulted in the disappearance of tachycardia, cardiac irregularity, and œdema. There is hyperplasia within the nodule. How does stimulation affect the interior of the nodule and leave the remainder of the gland comparatively nórmal ? Again, there is frequently hyperplasia in the tissue immediately surrounding the nodule. These facts for a long time made me subscribe to Plummer's view, but the steps in the gradation between these single nodules and the smooth symmetrical goitre of primary Graves' disease appear to me to be so complete clinically and pathologically that I cannot doubt that the view I have presented is more in accordance with the facts we are able to elicit in the present state of our knowledge. There are still many problems awaiting solution. Many writers have divided toxic

goitres into primary and secondary types. Some of the views put forward in this paper have been expressed by Allen Graham[15] in 1926, by Rienhoff[14] in 1927, by the writer[16] in 1927, and by Bérard[28] (Lyons) in 1929, each working independently. The absence of references to German work is due solely to my inability to read the language, but this article is in the main a record of personal views developed as the result of work carried out in the Surgical Professorial Unit at St. Bartholomew's Hospital. It does not contain a complete record of the literature of the subject.

SURGICAL TREATMENT.

PRELIMINARY CONSIDERATIONS.

It will have been realized from the evidence set forth in the first part of this paper that the disease is essentially the same whether the case is called primary or secondary, exophthalmic goitre or toxic adenoma, fully developed or *forme fruste*, any apparent differences being due to variation in one or more of the three 'factors' described. Nevertheless treatment must not be rigidly standardized, and must vary according to the clinical condition of the patient when the advice of the surgeon is first sought. I will state my usual practice briefly on the aspects about which there is little divergence of opinion, and discuss at greater length the question of auricular fibrillation, exophthalmos, permanence of results, extent of the operation required, preliminary treatment, and death-rate.

If the case is primary, operation is not performed in the earlier months. At this stage many patients recover with appropriate treatment; in some others the essential causes—the pathological stimuli—are still so active that operation would fail to achieve its maximum result. Septic foci are removed, adequate rest is given, and small doses of iodine are administered.* If the patient does not improve, or any sign of complication appears, operation is considered. The economic question is of importance. A well-to-do patient can afford time for rest, and may be willing to live a sheltered life with restricted activities, while a poor woman may be compelled to earn her living or manage her household. Visceral damage, while it may begin at any time in any patient, is therefore prone to occur earlier in the poor, and, both for economic reasons and to prevent or cure complications, operation must be performed earlier in the case of the poor. If operation is delayed too long, ultimate cure may be less complete.

If the disease is of the secondary type, nothing is gained by delay, and much may be lost. Operation should be performed as soon as the patient has been given sufficient preparation. This may be an arbitrary statement, seeing that the disease is essentially the same in each case; but when the disease is secondary, the thyroid gland has already been the seat of pathological change, therefore restoration to normal is less likely; also the patient is generally

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* Some surgeons object to the use of iodine except in the pre-operative period. Iodine with other appropriate treatment is very beneficial in early cases. Its use cannot be denied to physicians. In a case where operation is obviously indicated it is wise to withhold it until twelve or fourteen days before the operation.

older, the heart muscle is older, and for these reasons cardiac decompensation occurs more quickly, even though the degree of intoxication is less.

This view of the wisest time for operation is a personal one, and there are still sharp differences of opinion. It is good for us as surgeons that some patients desire X-ray treatment, and that others wish to continue medical treatment when we consider that the time for these measures is past and that operation is essential, for in this way our beliefs are continually being tested. But certain statements in publications which cannot be ignored would seem to show a lack of knowledge of the degree of disability in which patients find themselves, or—if this is known—of what can be done to help them. Let me mention four :—

1. Kessel, Hyman and Landl,[17] state that with ' skilful neglect ' the prognosis is excellent.

2. Barker[18] has stated that the course of the disease associated with diffuse hyperplasia of the whole gland—that is, primary Graves' disease— " is probably two or three years no matter how you treat it (medically, surgically, or radiologically)."

3. A surgeon[19] in a large provincial town in England very rightly asks, in a recent issue of the Lancet, " what the prognosis is in patients who decline operation ", stating, inter alia, that " the patient is not interested in the percentages of deaths and recoveries. What she wants to know is the prognosis without operation in her individual case."

4. The authors[20] of Jacobson's Surgery, after a balanced discussion, raise the question whether the benefit to be obtained from the operative treatment justifies the risk which is necessarily run. This volume also raises another point which I wish to discuss later—the extent of the operation, if performed.

These are very legitimate questions to raise. They crystallize the aspects of the subject that are profitable for discussion, and they merit a detailed answer. (I wish everything I say to apply only to those patients who have failed to respond to medical treatment.)

The reasons for operation come under two headings : (a) Economic ; (b) To prevent the grave complications of the disease, or to relieve them when present. Of the four published statements to which I have referred, the first three raise the economic question ; the fourth the prevention and the cure of the grave complications. (We should use the term 'sequelæ' rather than 'complications', for in many cases these grave symptoms are inevitable sequelæ, not something accidental.)

Regarding questions 1 and 2. I have taken a consecutive series of 300 patients coming for operation, and divided them into groups showing the duration of the disease in years. These are not all cases of primary disease.

LENGTH OF SYMPTOMS.

Over   4 years   -   125 patients
Over   6 years   -   89   ,,
Over 10 years   -   62   ,,

and in 24 only was the history less than 4 years.

These 300 patients had had more than 'skilful neglect'. Each had sought the best treatment that, in her station, she was able to obtain. The result

for these patients has been great distress, and great economic loss for themselves, their families, and the community. I am keeping to facts, but in passing we should remember that of those who started level with this 300, we have no evidence how many recovered in Barker's two- or three-year period, nor, on the other hand, how many died.

Next, taking question 3. The writer states : " The patient is not interested in percentages of deaths and recoveries. She wishes to know the prognosis in cases where the patient declines operation." We all agree that some get well. A survey of the last 1000 patients operated upon by me reveals evidence of the condition in which many patients find themselves when operation has been delayed. I will mention briefly five groups : (1) Patients who develop eye complications other than exophthalmos ; (2) Those who develop glycosuria ; (3) Patients who develop mania ; (4) Those who develop auricular fibrillation—many with cardiac decompensation ; (5) Patients who die.

FIG. 259.—Chemosis and ulceration.

Group 1. *Eye Complications.*—I have had ten patients who developed corneal ulceration while still under treatment. *Fig.* 259 shows one in whom the conjunctiva was extruded to a degree in which it was ulcerated and almost strangulated. In some the eyelids were sutured together to prevent loss of the eyes, and separated when the danger was passed (*Figs.* 260 and 261). *Figs.* 262 and 263 show two patients in whom an eye was lost.

FIG. 260, 261.—In both these patients the eyelids were sutured together because of the imminent danger of loss of the eyes. In both, the eyes have receded following operation.

Group 2.   *Glycosuria.*—Twenty-five patients have developed glycosuria, 9 of them very severely.

Group 3.   *Mental Disturbance.*—Seventeen patients have developed mania. Five died in acute mania without operation; some developed chronic mania to an extent that made operation obviously unwise; some were operated upon while quite bad mentally. Only one who was operated upon failed to recover mental balance, and she had been in a lunatic asylum before operation—I did not know this at the time.

Group 4.   *Auricular Fibrillation.* —I have operated upon 131 patients with permanently established auricular fibrillation, and in most of these the disease had progressed to this condition while the patient was under observation and treatment.

Group 5.   *Death.*— I have not kept a list of the patients who have died without operation, but I can recall 12 who on admission were either too ill for operation and died almost at once, or died while awaiting their turn for admission.

FIG. 262.—Loss of left eye.

This is some answer to the question as to what the prognosis is in patients who have not been operated upon. Therefore I think we can take it that, after allowing for those who respond to other methods of treatment, some patients remain gravely ill, and for these some further service is required. Whether that service can be rendered by us as surgeons with a sufficient margin of safety is the question.

FIG. 263.—Loss of one eye.

AURICULAR FIBRILLATION.

Let us take one complication occurring in this disease—established (continuous, not paroxysmal) auricular fibrillation. Auricular fibrillation frequently has other causes, and when due to these other causes is scarcely remediable. Even in this disease I am unaware of its disappearing after it has become completely and permanently established before it was shown that an adequate operation could bring about this result. Read[22] writes : " At this point it should be mentioned that one of the chief aims in the management of this disease is to prevent myocardial damage, which leads to decompensation and is the one residuum of this disease which is most distressing and from which there is often no recovery." He continues : " It sometimes

happens that the patient will be found at the first examination already to have auricular fibrillation. The prognosis in such cases developing auricular fibrillation early in the course of the disease is unfavourable for recovery."

When discussing etiology I selected the heart as an organ suitable for indicating the effects of toxicity, because the effect on the heart can be observed and measured by the electrocardiograph. In dealing with the surgery of the disease the heart again gives us one of the clearest indications of the result of treatment. For long it was held, and I know is still not uncommonly believed, that when auricular fibrillation is present, especially when it is associated with a goitre which may have diminished in size, there must have been an antecedent history of rheumatic fever, arteriosclerosis, or syphilis, and that one or other of these conditions, and not the goitre, is responsible for the fibrillation. And it was longer still before it was realized that when these conditions had been established for months or years the irregular heart rhythm could be restored to normal, and that patients with widespread œdema could be restored to active life by surgical operation. This condition has been stated repeatedly to be a contra-indication to operation. I operated upon the first patient of this type in 1908 and found that this complication did not add to the danger of the operation.[23] I continued to operate upon patients of this type[24] only with the idea of improving their general condition, for this improvement was very definite, and then in six patients in whom fibrillation had become permanent, normal rhythm returned spontaneously. There still remained others who, although greatly improved, did not regain normal rhythm.

The next stage began through my association with Professor Fraser in the Professorial Units of St. Bartholomew's Hospital. Fraser had been especially interested in heart problems, and had become accustomed to the use of quinidine with its powers and limitations. The position now is that with combined medical and surgical treatment, many patients whose hearts have fibrillated permanently even for many years—some of whom have œdema extending to the upper part of the trunk, others of whom have been bedridden for months—have been restored to a health level with normal heart rhythm and free from œdema. Shortly after normal rhythm has been restored, quinidine, if it has been used, may be stopped. Normal rhythm cannot be attained for more than a short time by quinidine if an inadequate operation has been performed. I will refer briefly to three of these patients: one to show the length of history, one the degree of persistent œdema, and one the severe chest condition present.
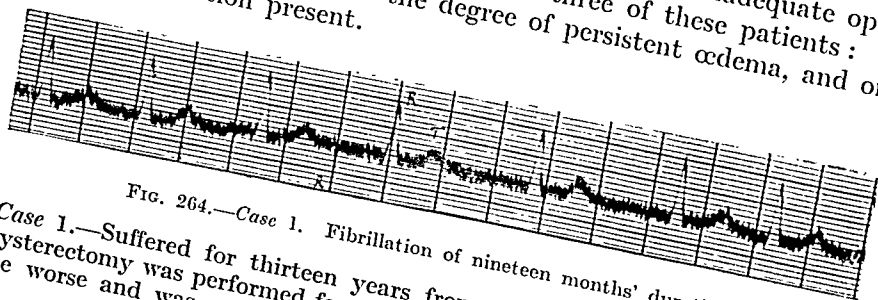
FIG. 264.—Case 1. Fibrillation of nineteen months' duration.

Case 1.—Suffered for thirteen years from goitre with palpitation. Ten years ago hysterectomy was performed for fibroids; immediately after this the palpitation became worse and was associated with great loss of weight and sweating. Eight

years ago the patient came to St. Bartholomew's Hospital, and has continued under medical treatment since. Nineteen months ago fibrillation began and has continued. Her electrocardiogram is shown in *Fig.* 264.
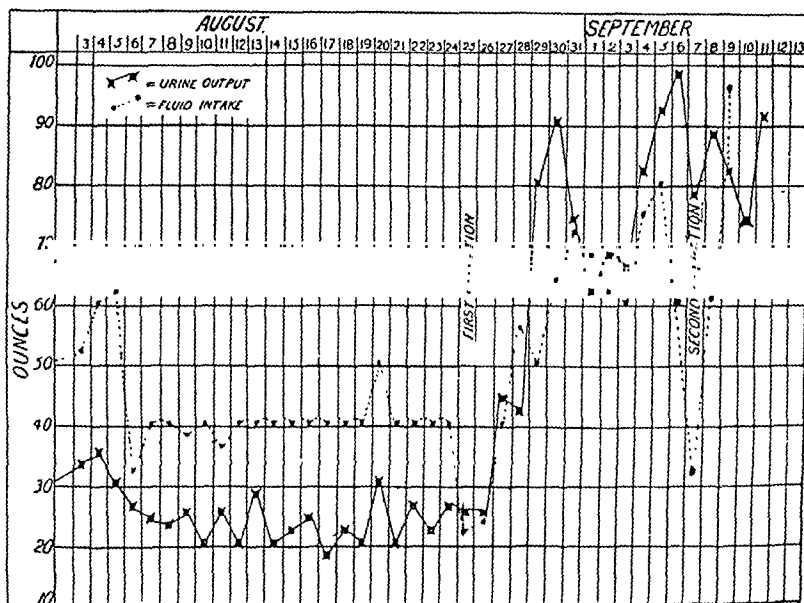
FIG. 265.—*Case* 2. Showing the output of urine for three weeks while under treatment with digitalis and diuretin, and the increase immediately following removal of part of the thyroid gland.

FIG. 266.—*Case* 3.

Case 2.—This patient had five years' continuous irregularity of heart rhythm with exophthalmos. She entered hospital with legs, thigh, and body œdematous; fluid in the abdominal and pleural cavities. The œdema of the thighs and the abdomen made it very difficult for her to be propped up in bed. The urine for three weeks was frequently down to one pint a day and never more than a few ounces above this. All known medical measures were used in hospital. The patient failed to respond and continued to lose ground. *Fig.* 265 shows the output of urine and the intake of fluid.

Case 3.—This man's bronchitis could not be brought under control even with long rest and treatment in the medical wards. It was partly dependent on his congestive heart failure. By ligating arteries one at a time, and subsequently dealing with each lobe on successive occasions, he was carried safely through. *Fig.* 266 shows his photograph and his electrocardiogram.
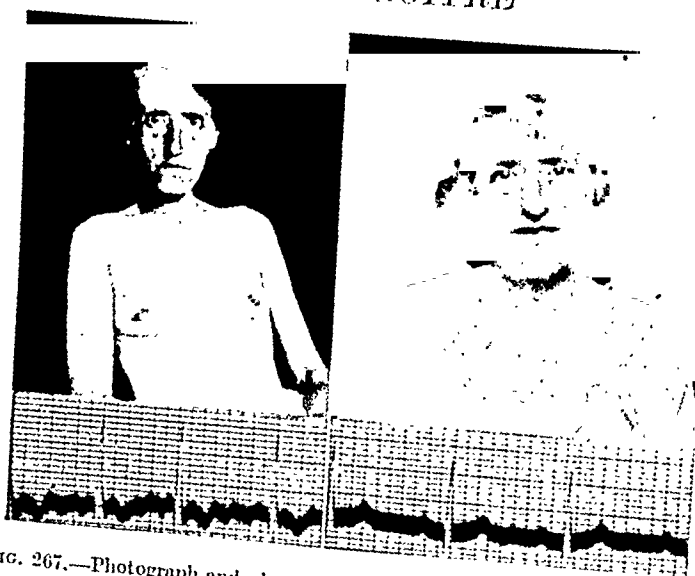
FIG. 267.—Photograph and electrocardiogram before and after operation.

a

b

FIG. 268.—*a*, Before operation ; *b*, After operation.

a

b
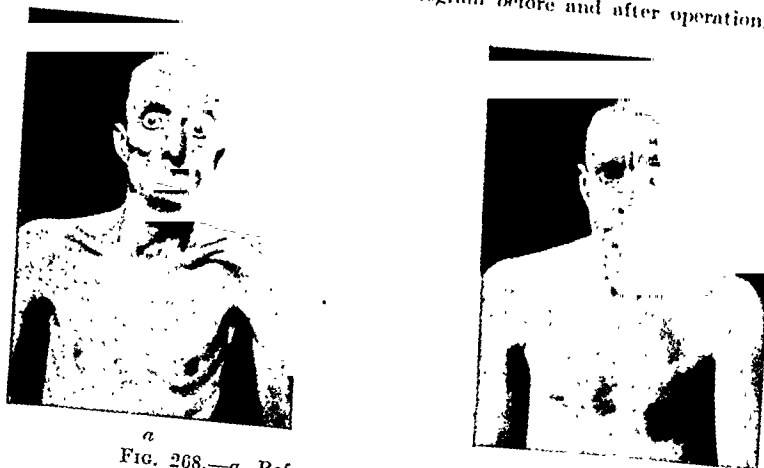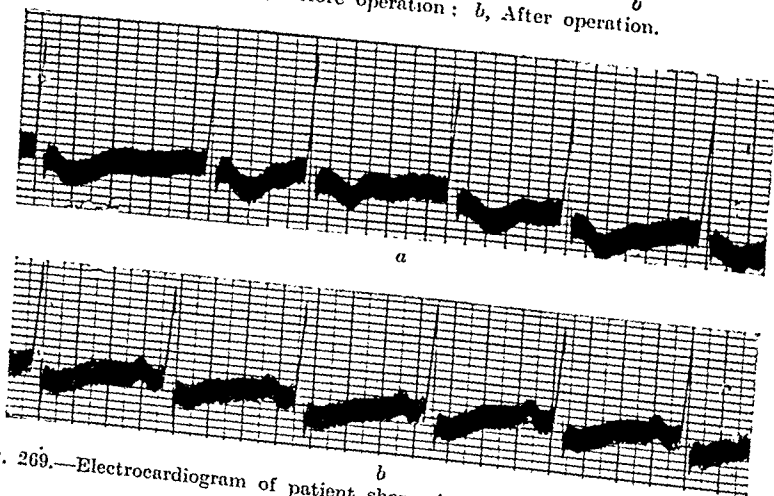
FIG. 269.—Electrocardiogram of patient shown in *Fig.* 268—*a*, before operation ; *b*, after operation.

I have taken a series of 100 consecutive patients with permanently established and continuous auricular fibrillation. I have not included those in whom *paroxysmal* fibrillation appeared to have become a permanent condition. *Figs.* 267, 268, 269, show electrocardiograms before and after operation, and photographs of the patients from whom these were obtained. It is interesting to see the decreasing pulse deficit following the second operation in a patient (*Fig.* 270). The first operation with subsequent medical treatment had failed to achieve this. Of these 100 patients regular rhythm has returned spontaneously in 48 after a sufficiently extensive operation. In 32 regular rhythm has returned after operation with the assistance of quinidine. Four felt so well after removal of one lobe that they were content to remain as they were; three of these four are living active lives; one died some years subsequently. In 7 who have had an adequate
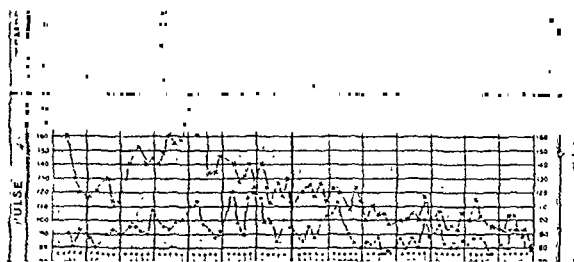
FIG. 270.—Decreasing pulse deficit following extirpation of an adequate amount of the second lobe.

operation the heart has not yet returned to normal rhythm. Nine of the 100 have died following operation. This may seem to be high, but it should be remembered how very ill those who constitute this series were.* (The death-rate for partial thyroidectomy in toxic goitre when almost all risks are accepted is 2·7 per cent.) Should we not rather say that 81 per cent of people who were completely invalided have been almost completely cured, while 88 per cent are able to live lives very nearly normal? It would be idle to say that patients in this condition can be operated upon without risk, but the expectation of life in this class without operation is very low.

Regarding the question of the permanency of the results obtained in this series of 100 patients, of the 81 in whom normal rhythm was restored, I believe only one has relapsed, and that was after six years of strenuous work, for this patient refused to limit her activities. It would be just as idle to state that these patients after operation have the physical reserves enjoyed by people who have not suffered from the disease. Almost all of them are living very active lives, and doing so with a degree of comfort which they had long ceased to expect.

Glycosuria and mental disturbance will be discussed on a subsequent occasion, but I must say something about exophthalmos.

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* In this respect Sir William Hale-White's[21] statistics should be remembered: Of 161 patients admitted to the medical wards of Guy's Hospital between 1888 and 1907, 18 died in hospital—just over 11 per cent. Undue weight should not be attached to these comparisons. Many patients in Hale-White's series would have been very ill on admission. Equally so were many in my series of fibrillators.

EXOPHTHALMOS.

It is frequently stated that this sign remains even when the other symptoms improve. It always becomes less if an adequate operation has been performed, but it may remain to some extent. The amount of improvement that may occur is shown in *Figs.* 271–275.

a *b*

FIG. 271.—*a*, 1925. Before operation. *b*, 1929. After operation.

FIG. 272.—*a*, 1926. Before operation. *b*, 1929. After operation.

FIG. 273.—*a*, 1922. Before operation. *b*, 1926. After operation.

FIG. 274.—The left eye was lost owing to exophthalmos and ulceration. The left eye in the second picture is artificial.

FIG. 275.—The interval between these two pictures is only a few months. The exophthalmos, chemosis, and ulceration have disappeared. The œdema of the lower lids has not yet done so.

THE EXTENT OF THE OPERATION REQUIRED.

In order that we may give this service to patients the operation must be adequate, and it must be reasonably safe. Regarding the extent of the operation required, Halstead,[29] in an article on " The Parathyroid Glandules : their Blood-supply and their Preservation in Operations upon the Thyroid Gland ", states that the greater portion of both lobes may need to be removed in hypertrophy of the thyroid gland. Almost all the articles published in 1907–11 state that the extirpation of one lobe, together with the ligation of an artery of the opposite side, would cure 75 or 85 per cent of patients ; and this belief is still expressed in some modern books.[20] By the end of 1907 I knew that my experience did not bear this out, and in 1908 I wrote[23] stating that it was essential to remove a sufficient amount of the second lobe before a patient could be cured. I published this again in 1909,[21] in 1910,[25] and in 1912.[26] I do not find other reference to partial extirpation of both lobes until the paper by Halstead[27] published in 1913.

A less extensive operation, even the ligation of an artery, may give surprisingly good temporary results, but these results are almost never permanent, and if any one thing more than another brings the operation into disrepute (apart from operating in unsuitable cases), it is an inadequate operation. The patient, after being allowed to expect that she will be better, finds that fibrillation, exophthalmos, rapid heart, tremor, hot skin—all the distressing symptoms—remain, or return after she has undergone a severe ordeal. She will be disappointed and annoyed, and so will her doctor. Three patients were admitted last year, each having had two operations performed, each having been led to believe that everything that could be done had been done, and that no more was possible, two of them with fibrillation still remaining, and all unable to work. In each there was a mass remaining, inconspicuous because it was deeply situated, and in each, on removal of an adequate amount of this, normal rhythm returned spontaneously. We should not be induced to operate upon a patient unless we have her assurance that she will let us complete, in stages, what may be necessary.

The matter of incomplete cure raises another question. Some patients with toxic goitre have, apart from it, an unstable nervous temperament, neurasthenia, visceroptosis, or other conditions which would prevent them feeling well under any circumstances. Operation upon these patients requires careful consideration.

There is also a class of patients with symptoms resembling those of this disease to some extent, but not due to toxic goitre. These patients are thin, perspire freely, and have a rapid pulse-rate. The thyroid gland is not enlarged. They are not suitable for operation.

SAFETY OF OPERATION.

Regarding the safety of operation, and surgical management generally, I will say very little.

1. The death-rate of operation, taking all cases of toxic goitre, has been 2·7 per cent. If practically all risks are accepted, that is scarcely likely to be lowered.

2. In elderly people it makes a great difference whether the condition is primary or secondary. At this time of life the primary condition is rare compared to the secondary. The primary condition in an elderly patient is always a serious surgical risk. In the secondary condition the surgical risk is not as serious as would be expected from the signs and symptoms of the patient. It is to be remembered that whether primary or secondary the disease is essentially the same, but in the secondary type changes in the gland preceding the development of toxic symptoms have lessened the amount of active epithelium. There may be an extreme degree of cardiac decompensation, but the symptoms referable to the central nervous system are not so great, and it is the latter which give the danger to operation.

MANAGEMENT OF PATIENTS.

Iodine.—The surgeons of the world owe a great debt to Henry Plummer for his work in discovering the measure of safety that is given to the operation through the administration of iodine in suitable doses. It has helped so greatly that the literature would lead us to believe that the operation is now quite safe, that the necessity for ligation of arteries has passed, and that generally the complete procedure may be performed in one stage. To some extent this is true, but it is not completely true. Plummer[6] pointed this out. His statement is that 37 per cent improved markedly and promptly, 32 per cent definitely, 11 per cent only slightly—about equal to what would be achieved by hospitalization and rest—and 5 per cent were not affected. All accurate observation confirms this view. The patients constituting the 11 per cent, and especially the 5 per cent, still remain dangerous risks. Unless this is recognized and the operation graded accordingly, the death-rate will be unduly high. Again, without doubt in elderly patients iodine treatment sometimes gives a false impression of safety.

Special Cases.—In the old and very ill, and the young and very ill, it is wise to ligate vessels at a preliminary operation, and, even then, to remove one lobe first.

MORBIDITY FOLLOWING OPERATION.

Apart from the death-rate, the morbidity of operation must be taken into account. Injury to a recurrent laryngeal nerve is still a very present danger. I have had three severe cases of tetany in something over two thousand operations. This condition is very distressing. Two of these had had much X-ray treatment previously ; the third had suffered from encephalitis lethargica. I simply record the facts. Halstead has shown that very occasionally the greater part of the parathyroid tissue may be situated within a lobe of the thyroid. I have once had a pulmonary infarct—non-fatal.

RADIOTHERAPY.

X-ray Treatment.—Regarding X-ray treatment I have to suspend judgement to some extent. I know that some patients with this disease are relieved by it, but cannot say just how many. Dr. Finzi and the writer are watching

some patients together. I know of four young women decidedly better, and one man in whom I am interested whose treatment was controlled by Dr. George Murray is back at work after several years' illness. In another, where not quite enough gland had been removed, X-ray treatment made an incomplete success into a complete one. I have no doubt that radiologists see some patients upon whom I have operated who have not been completely cured. On the other hand, since 1921 at least 31 patients have been sent to me for operation who had been given what had been regarded as adequate X-ray treatment, and were, when they came to me, without doubt very ill people— most of them gravely ill. The X-ray treatment had not been given casually in remote districts. It had in the main been given under skilled supervision and in big centres. These 31 include patients from the age of 17 to 60. Some had been at complete rest in hospital during the period of treatment; others had able practitioners outside and treatment under conditions of their own

choice as long as was considered necessary. Several of these improved while treatment was being given, but relapsed at once on cessation. With others the symptoms have been accentuated while under treatment, and many of the worst cases I have had with fibrillation and œdema had previously been treated by X rays. Burns still occur even under able supervision, and frequently the texture of the integuments has been so altered that when operation had to be performed healing was interfered with. I sometimes wonder whether the parathyroid glandules have their vitality lowered by X-ray treatment, for, as stated before, of the three patients who suffered from tetany subsequent to operation, two had received much X-ray treatment.

As a working rule I would suggest that X-ray treatment is inadvisable when

Fig. 276.—Damage to skin and deeper structures through injudicious X-ray treatment.

any of the graver complications are present, or in elderly patients where cardiac decompensation is present or imminent. In young patients without complications and where time is not of importance, it may be used ; but, as with all medical treatment, the results should be watched and other measures adopted if it fails. Especially should care be taken not to damage the skin. I become rather prejudiced because of the condition many patients are in when they are sent to me, where I cannot help thinking that the treatment has been persisted in too long, to the detriment of the patient. *Fig.* 276 is not shown in any controversial spirit, but patients still come in this condition. The morbidity of X-ray and medical treatment should be borne in mind as well as that of surgical treatment.

Radium Treatment.—After X rays one naturally thinks of radium. I have had four patients who had been given radium treatment. Two of them

were sent to me by the practitioners who had administered the treatment. All four were very ill when I saw them. None of them had improved, and two of the four had become alarmingly worse under the treatment. Notwithstanding this, further experience may prove radium treatment to be of value.

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MULTIPLE POLYPOSIS OF THE COLON.

BY JOHN H. ANDERSON AND O. A. MARXER,

RUTHIN CASTLE, (NORTH WALES.

MULTIPLE polyposis of the colon has been described as far back as 1721, and as Sir William Wheeler[1] recently pointed out in this JOURNAL, is not so rare a condition as was at one time supposed. In 1924 J. E. Struthers[2] reviewed twenty cases of multiple polyposis in the alimentary canal, mostly in the colon. The difficulty lies in the diagnosis and, as the symptoms are those of ulcerative colitis, the sigmoidoscope and X rays offer the only means of recognizing the condition short of opening the abdomen and colon. Radiographs of polyposis are hard to come by, and the following cases are recorded mainly because in each the diagnosis was made by X rays as well as by the sigmoidoscope ; they show also that when the diseased area is beyond the reach of the sigmoidoscope the diagnosis may be made by the X-ray picture alone.

CASE REPORTS.

Case 1.—A. B., male, age 61.

HISTORY.—One sister died from cancer of the rectum ; another had ulcerative colitis, and carcinoma of the cervix ; one brother had ulcerative colitis. The patient had been constipated all his life. At the age of 38 he passed hæmorrhagic stools and suffered from loss of weight ; the cæcum and part of the ascending colon were removed. At this time the pathologist reported that the bowel was enormously dilated with a thin atrophied wall. There was severe colitis again at the age of 57 and several mild attacks occurred later. In June, 1927 (three months before admission), the patient passed frequent stools containing mucus at first, and in· August they became blood-stained. He gradually lost weight and appetite, and took no interest in his work.

ON ADMISSION.—He was admitted to Ruthin Castle in September, 1927, complaining of frequent colicky pains, with passage of flatus and liquid offensive stools, vomiting, thirst, loss of weight and strength.

ON EXAMINATION.—The patient was undernourished and too ill to weigh, but was found to be 7 stone 10 lb. two months after admission. His skin was irregularly pigmented, the temperature 100·5°, pulse 105, the tongue dry and furred, with desquamation of epithelium on the dorsal surface. His abdomen was distended and gurgling ; there were general tenderness and spasms of pain every fifteen to twenty minutes. He passed seven to twelve motions in twenty-four hours, the stools being black, liquid, and offensive ; they contained blood, pus, and mucus, but no parasites were found or pathogenic organisms on culture. The blood-count was as follows : Hæmoglobin, 85 per cent ; red cells, 3,600,000 ; white cells, 3800 per c.mm. ; on differential count immature forms were numerous (70 per cent) ; eosinophils, generally normal (1 per cent), on one occasion rose to 6·5 per cent.

X-ray Examination.—Owing to the patient's condition full examination by an opaque meal was not possible. A barium enema filled the colon readily, all parts being capable of dilatation except the rectosigmoid junction, which was narrow and ragged. The ascending and transverse colon were dilated, showed inhibition, and tended to expel contents too quickly. In the descending colon and sigmoid there

was a lack of segmentation, the outline was ragged, and nodular filling defects,
. · 'ŀ·'·' ·; ¹· ·· ·comb appearance, were present throughout (*Fig.* 277).
` · ·· . · (E. I. Spriggs).—Mucous membrane acutely inflamed, swollen
rugæ, passage narrowed at 13 cm. by a ring of polypi. One polyp was removed
which the pathologist reported to be a small polypoid fold of large bowel mucosa,
with engorged vessels supported by a fibro-inflammatory stroma, the gland tubules
being in a state of secretory over-activity.

DIAGNOSIS.—Ulcerative colitis with multiple polyposis of descending colon and
sigmoid.

This patient did well under prolonged treatment (four months) and was able
to resume work. In his case the polyposis seemed to be subsidiary to the ulcerative
colitis in the production of symptoms.
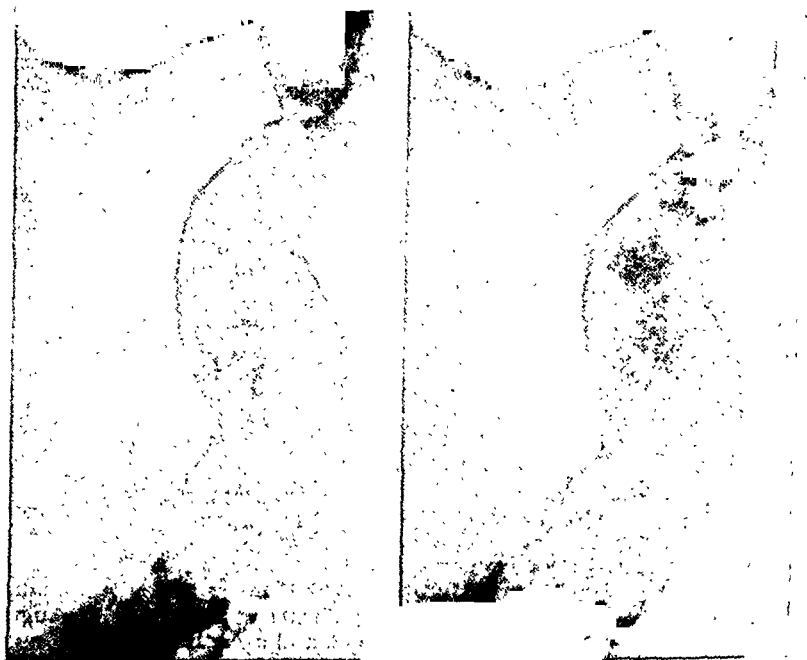
FIG. 277.—*Case* 1. Barium enema showing portion of sigmoid colon. The illustration
on the right was taken one second later than the one on the left.

Case 2.—C. D., female, age 34.

HISTORY.—The family history showed no cancer or colitis. At the age of 23
the patient suffered from constipation ; occasional bright blood with the stools,
and tenesmus ; the motions gradually became frequent, small, precipitate, and
finally were mainly blood and mucus. She steadily lost strength, grew anæmic,
and though the motions became larger they remained fluid. At the age of 29 she
was admitted to a nursing home with profound anæmia, colic, frequent blood-stained
stools, rapid pulse, and a temperature of 101°. The abdomen was opened in May,
1924, to perform an appendicostomy. The whole large bowel felt indurated and the
transverse colon was red on its peritoneal surface and œdematous. Irrigation
through the appendicostomy had to be stopped after a few weeks, as it was badly
borne, but the patient slowly improved and was ultimately able to get about again.
The next summer symptoms recurred with vomiting and pain severe enough to
require morphia ; this relapse was followed by slow improvement under treatment,
the motions, however, remaining frequent and precipitate. Three years later, in
August, 1928, symptoms again recurred, but did not yield to treatment.

ON ADMISSION.—The patient was admitted to Ruthin Castle in May, 1929, complaining of frequent motions, occasional vomiting, weakness, and breathlessness on any exertion.

ON EXAMINATION.—The patient was well nourished and weighed 8 stone 4½ lb., her lips were colourless and her scleroties pearly. The pulse was 106, with frequent extrasystoles; the abdomen full, showing no tenderness and good muscular tone: the spleen was palpable, and the appendicostomy patent. The motions varied from seven to fifteen in the twenty-four hours; they were always precipitate and always contained blood, mucus, and pus; there was occasional tenesmus; the consistence varied from a large formed stool with streaks of darkish blood, to small motions, mainly clear or yellowish mucus, with specks of bright blood and faecal material; non-haemolytic streptococci were the chief organisms recovered on culture. The blood-count was as follows: Haemoglobin, 28 per cent: red cells, 2,700,000;

FIG. 278.—*Case 2.* Barium meal showing colon eight hours after ingestion.

white cells, 5200 per cmm.; the differential count showed numerous immature forms (23·6 per cent), and normal eosinophils (2 per cent).

On the clinical evidence a tentative diagnosis of ulcerative colitis was made, and, though polyposis was not thought of, the following atypical points were noted: (1) The condition of the colon as seen at the operation five years before; (2) The patient's general nutrition and hearty appetite did not support long-standing colitis; in addition, her appearance suggested that the anaemia was due to haemorrhage from a clean rather than from an infected area; (3) The skin of the abdomen had not the 'dead feel' of the colitic patient, and the stools were often formed and almost normal except for streaks of blood.

X-ray Examination.—Barium meal: the stomach was empty in four hours; the terminal ileum, the ascending and proximal part of the transverse colon were tender and expelled their contents more quickly than normal, barium reaching the

rectum within eight hours. The whole colon gave a honeycomb appearance with concave impressions on the margins (*Fig.* 278). This appearance was again seen with barium enema.

Sigmoidoscopy (E. I. Spriggs).—At about 6 cm. three small projections the size of a pea were seen, they were covered with mucous membrane and the tops were rounded ; a smaller one near by was like a short tail sticking up. At 13 cm. there was a small raised plaque, and just above this another projection about the size of a pea with three small convexities of the mucous membrane near it. (This appearance resembles that described and illustrated by Cuthbert Dukes.[3]) The instrument could not be passed beyond 16 cm. owing to a spasmodic contraction of the bowel. There was a slight redness of the mucous membrane, but the nodules had not the appearance of those round a cancerous stricture, and no ulceration was seen.

DIAGNOSIS.—Multiple polyposis of the colon with ulcerative colitis.

X-RAY TECHNIQUE AND APPEARANCES.

Unless the radiologist is warned of the presence of colitis, the polyposis may be missed, owing to the rapid passage of the meal through the colon. Frequent examinations are necessary, and the general routine of the ordinary barium meal may require considerable modification. The barium enema in *Case* 2 was given fifteen minutes after a hypodermic injection of morphia (gr. $\frac{1}{4}$) and atropi nesulphate (gr. $\frac{1}{100}$). The material was run in at low pressure (18 in.) with the foot of the couch raised and the patient prone. She was asked to lie as still as possible and especially to resist the inclination to empty the bowel. With these precautions adequate time was given to get good films.

In polyposis the filled bowel is studded with concave impressions on the otherwise smooth margin, and the mucosa in general presents a mottled or honeycomb appearance, probably due to only a thin coating of opaque material being present in parts, owing to displacement by the polypi. If the bowel is too distended to show this mottling, pressure with a wooden spoon or air-bag may produce it. Serial films showed some exaggeration of the lesser movements of the colon, but frequent incomplete mass movements were present with a slowing of the relaxation phase and absence of segmentation. The nodular filling defects at the margins of the filled bowel and the honey-comb appearance of the colon as a whole are the main features in excluding uncomplicated colitis.

Polypi of the colon are of two types, inflammatory and true tumours, the latter being more frequently met with. J. H. Saint[4] describes the inflammatory polypi as " strips of mucous membrane which have become detached along almost their whole length, due to the undermining character of the ulceration." It is hard to imagine how structures of this nature can give the honeycomb appearance seen in *Figs.* 277 and 278. In fact it is uncertain whether inflammatory polypi can be diagnosed radiographically. In our opinion polypi of both types were present in *Case* 1, those seen in the lower bowel with the sigmoidoscope being inflammatory, and those shown in the descending colon and sigmoid by the X rays being true tumours. In *Case* 2 adenomatous tumours were demonstrated by both sigmoidoscope and X rays and there was no evidence regarding polypi of inflammatory origin. This

view is supported by the appearance of the mucous membrane adjoining the polypi; in *Case* 1 it was inflamed, but there was no evidence of disease in *Case* 2.

SUMMARY AND COMMENTS.

1. Two cases of multiple polyposis of the colon are described in which the diagnosis was made by X rays as well as by sigmoidoscopy. The radiological appearances and technique are described and discussed.

2. In one instance the accompanying colitis was acute (*Case* 1), in the other it was chronic with exacerbations (*Case* 2). In *Case* 1 other members of the family had suffered from ulcerative colitis, cancer of the rectum, and cancer of the cervix, thus agreeing with the experiences of D. H. Pennant[5] and J. P. Lockhart-Mummery.[6]

3. The general colitic nature of *Case* 1, especially the stools, is contrasted with the clinical picture given by *Case* 2, in which it is surmised that the polypi were of longer standing, and they were thought to be true tumours rather than merely inflammatory in origin.

4. Whilst the anæmia was greater in *Case* 2 the nutrition was better. It would appear that polyposis gives rise to less abdominal pain and interferes less with nutrition than colitis but is more liable to cause bleeding.

5. In each case constipation was an early symptom, if not the earliest.

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A REMARKABLE MECKEL'S DIVERTICULUM.

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THE literature on Meckel's diverticulum is already voluminous, but the unique size of the one described below and its unusual anatomical position appeared to me to justify record.

HISTORY.—Beatrice S., age 37, of Killamarsh, near Sheffield, was admitted to the Sheffield Royal Hospital on March 1, 1928 ; she died on March 14.

The patient was admitted on account of severe abdominal distension, dyspnœa, and abdominal colicky pain. She stated that the abdomen had always been big, and was sure that it had always been larger than it should have been. She always suffered from constipation, and this and the distension had always been much worse during pregnancy. During the previous three months there had been a further increase in the size of the abdomen accompanied by great difficulty in getting the bowels to work. She had had severe colicky pain every day for a month and had felt sick ; she had vomited a little during the week prior to admission. The bowels had only been opened every other day for a long time, and lately as many as five days had passed without a motion.

Recently the shortness of breath on exertion had become so bad that the patient had had great difficulty in walking up a hill and in performing the essential parts of her domestic work. She stated that the shortness of breath on exertion had troubled her for five or six years at least, and two years ago, when she was carrying her last child and was nearing term, it was exceptionally severe. She had had three children and there had always been severe trouble with distension of the abdomen during pregnancy, the patient thinking that she was pregnant with more than one child ; but this had never been the case. The abdomen had never gone down completely after confinements as she thought it should have done. She was sure that the abdomen had gradually got larger each year. She had been 'unwell' in November, 1927, but apart from a little bleeding towards the end of January, 1928, she had seen nothing since. There had been difficulty in starting to pass water, this having troubled her during each pregnancy ; but when not pregnant there had been no trouble of this kind and no frequency. She did not suffer from a cough and had not lost weight, though she had been thin for the past fifteen years except 'in the belly'.

ON EXAMINATION.—The patient was a woman of thin type with a healthy complexion. There was no cyanosis or jaundice, and examination of the mouth was negative apart from some defective teeth. As she lay in bed she appeared to be comfortable when propped up, but when placed in the recumbent position she had difficulty in breathing. No adventitious

sounds could be heard in the chest, and the heart appeared to be free from abnormality.

The abdomen was enormously, uniformly distended, and through the thin, taut parietes peristalsis of small intestine type could be plainly seen. There was no evidence of any free fluid. To percussion the left half of the abdomen was hyper-resonant, whereas it was noted to be dull on the right. A lump could be felt in the hypogastric and left iliac regions rising out of the pelvis and with a rounded upper end. It did not disappear after catheterization and was apparently a uterine swelling This was not dull to percussion. Examination of the abdomen was extremely difficult on account of the marked distension. No tenderness was present and no fluid thrill elicited.

Mr. J. Chisholm very kindly examined the woman for me and his report on the pelvic swelling was as follows :—

" The patient's history of amenorrhœa varies slightly from the history she has given to you. She says she was unwell in November and also in December and bled for one day on Jan. 7. There is a curious rounded swelling rising above Poupart's ligament on the left side with some slight resistance to the right of this. The cervix uteri is softened and cyanosed. I think the swelling is an enlarged, misplaced uterus—size (?) 4 months, not tender or fixed. Nil felt extra-uterine. Examination is not easy."

No secretion could be obtained on squeezing the breasts. Rectal examination, after several enemata had been given, proved negative.

The woman was plainly suffering from chronic intestinal obstruction and was probably about three or four months pregnant. Whatever the cause of the obstruction, it was evident from the patient's clear history that the marked abdominal distension had not suddenly appeared but had slowly been increasing for years. The distension had become so severe two years ago that by the time she reached the end of pregnancy severe symptoms had resulted from pressure on the diaphragm. Now, at the period of three months, she had already symptoms referable to pressure on the diaphragm and bladder. It was extremely difficult to make a diagnosis of the cause of the distension and the associated chronic small intestinal obstruction. It was considered most probable that there had been a tuberculous peritonitis with a loculated collection of fluid on the right side. If this was correct, then the obstructive symptoms presumably were the result of adhesions. The uterus had been by some means displaced to the left side of the pelvis.

The patient was given extra fluids for a week by proctolysis and hypodermoclysis. Glucose was added to the rectal salines. (She had been afraid to take food freely for the past three months, as she was sure that this caused the abdominal pain.) A barium meal examination was not made, as it did not appear at the time that it would be likely to throw further light on the case. In view of the operative findings I regret that this was not done.

OPERATION (March 7, 1928).—The abdomen was opened by a paramedian incision from the umbilicus to the pubis. The wound had been first infiltrated by novocain, and when the abdomen was opened ether was given. The hand passed into the pelvis immediately found a pregnant uterus of three to four months' gestation. The coils of small intestine were slightly distended, but

not so markedly as one had expected to find them. The hand then encoun-tered a large tumour extending from the right iliac fossa to the liver above and filling the whole right half of the abdomen. Its lower end was in contact with the enlarged uterus, but between them—on the right side of the uterus —descended the sigmoid colon. The liver appeared to be displaced over towards the left side of the upper abdomen. The huge mass was covered by peritoneum on the anterior surface and on the right side; here the peri-toneum became reflected on the parietes. On the left side the omentum was adherent to and obscured this surface. The posterior surface was lying directly upon the posterior abdominal wall. The upper end of the tumour was rounded and so firmly pressed against the liver that the hand could not be inserted between them. The liver was decidedly elevated by the swelling. The tumour wall was typical of an enormously distended piece of bowel. It contained material of putty-like consistency, since it pitted on pressure of the
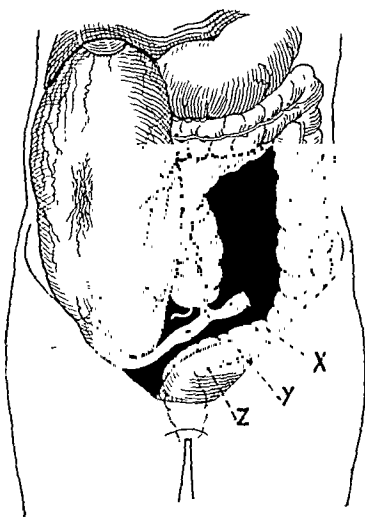
FIG. 279.—Findings at operation.

finger and these dinted pressure areas showed no tendency to fill out when the pressure had been removed. The cæcum was lying to the left side of the lower end of the tumour with the ascending colon running vertically upwards in the mid-line of the body (*Fig.* 279). The lower end of the dis-tended pouch of bowel narrowed somewhat and overlapped the right pelvic brim. Here it became continuous with a coil of intestine which ran straight into the hypertrophied and slightly distended last coil of the ileum. The ileum also communicated with the cæcum. The terminal two inches (it seemed no longer than this as the condition was seen at operation) of the ileum communicated with this portion of small gut as shown in *Fig.* 279. The ileum appeared to run almost directly into the lower end of the pouch, and a short piece of bowel, leaving this at an angle, entered the cæcum. It was plain that the ileum ran from X to Y and so through the ileocæcal valve into the cæcum, but the communication Z with the huge pouch had caused an angulation at the junction of X and Y. The lower end of the pouch appeared to have a longitudinal band on its anterior surface which gradually disappeared as it ascended the pouch. This gave the lower end of the pouch a close resemblance to large gut.

It was not easy to make out the exact state of affairs in this region between the enlarged uterus in the pelvis and lower end of this enormously distended piece of bowel. Neither Mr. Chisholm (who very kindly assisted) nor I had knowledge of such a condition having been encountered before. Removal of the huge sac, firmly adherent posteriorly, was clearly out of the question. We both felt it was most likely to be an enormous Meckel's diver-ticulum, but its size, position, fixation, solid fæcal contents free from flatus, and its communication with the ileum, apparently within a couple of inches

of the ileocæcal valve, appeared to us peculiar. The semblance of a longi-
tudinal band also added to the confusion.

The patient was taking the anæsthetic very badly and breathing was
very laboured. It was plain that above all an attempt had to be made to
drain the huge fæces-laden sac. The sigmoid was adjacent to the lower end
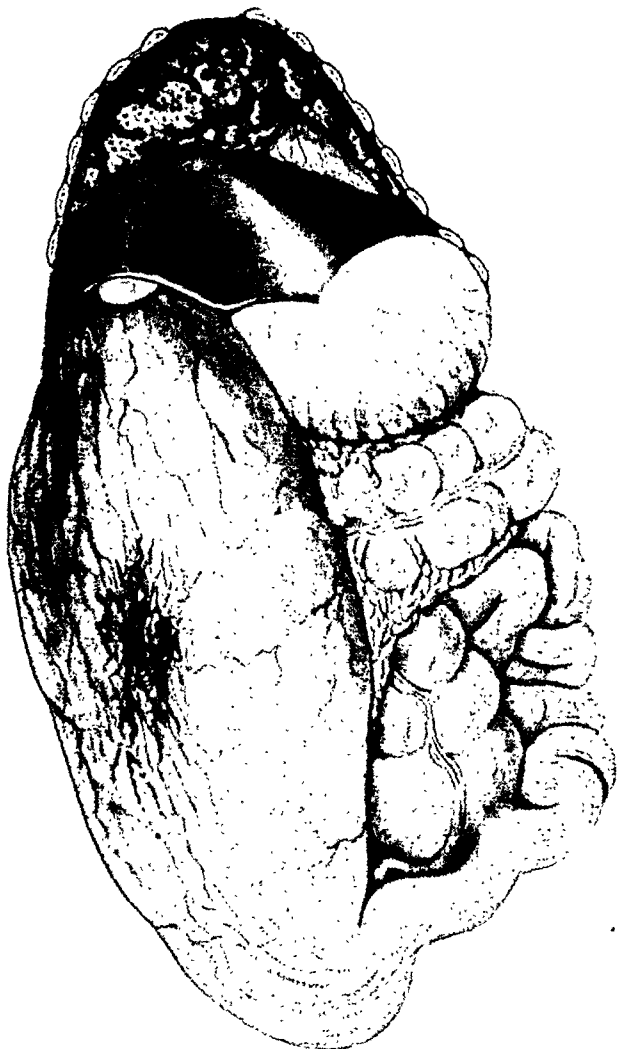
FIG. 280.—Drawing of the diverticulum made at autopsy. It clearly shows the
large size of the pouch, the small thoracic capacity, and the mode of termination
of the ileum.

of the sac and this was laterally anastomosed (with no little difficulty) to the
lower end of the sac and a rectal tube passed up to the anastomosis from the
anus. The abdomen was closed and the patient returned to bed. We now
felt sure that the sac must be an unusually large Meckel's diverticulum, the
contents of which must have been slowly accumulating for years.

SUBSEQUENT PROGRESS.—The progress after operation was as follows :—

March 8.—The pulse was thin but only 84. Propped up in bed the patient looked comfortable, but breathing was more difficult than before the operation. Temperature 98°.

March 9.—She was much the same. The abdominal distension did not appear, however, to be any less, and there had been no improvement in the breathing. Temperature 98°, pulse 100.

March 12.—The wound was clean and the clips were removed. She was, however, weaker. There had been no vomiting since the morning following operation. She had a slight cough and laboured breathing. Temperature 98·2°, pulse 112, respiration 30.

March 13.— In the evening she aborted and was delivered of a four-months fœtus. Previously the bowels had been opened and flatus freely passed. After the abortion the pulse became much faster, 136, and she rapidly worsened.

March 14. — She remained extremely ill without responding to the usual stimulating measures (including blood transfusion), and died in the early hours of March 15, the eighth post-operative day.

POST-MORTEM FINDINGS. — The coloured drawing (Fig. 280) most clearly depicts the state of affairs met with at the autopsy; it is reproduced from a drawing which Miss E. M. Wright made in the post-mortem room. When this was done the parts had not been disturbed (beyond bringing the ileocæcal region to the surface in order the more clearly to depict the anatomical arrangement in this area). The painting shows the size of the Meckel's· diverticulum (the omentum adherent to its left side had been separated and cut away) and how it had by gradual growth displaced the abdominal organs into the left half of the abdominal cavity. The extreme elevation of the diaphragm makes the thoracic capacity
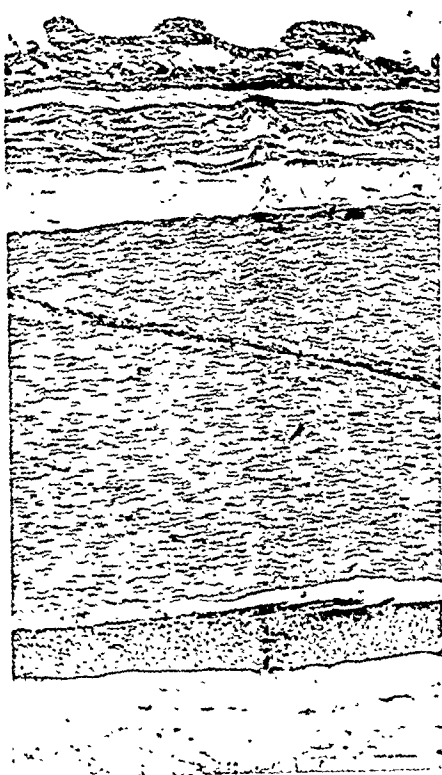
FIG. 281.—Transverse section of wall of diverticulum.

extremely small compared with the size of the abdominal cavity. It is at once obvious that the pulmonary vital capacity must have been very small indeed and the action of both the lungs and the heart seriously encumbered. There was no peritonitis around the sigmoid anastomosis to the diverticulum (not depicted). The lungs were markedly congested. So far as I could make out the anastomosis had failed to produce any evacuation of the contents of the diverticulum. The diverticulum was firmly fixed over

its entire extent to the back of the abdominal cavity, and in removing it I had to cut its posterior adhesions with a scalpel. There was no evidence of any persisting peritoneum posteriorly. The pouch was filled by solid fæcal material and no gas or fluid material was present. Its communication with the ileum was firmly ligatured and the diverticulum after removal was found to weigh *six pounds four ounces*. Death appeared to have been due to post-operative pulmonary congestion producing syncope. The abortion was an additional factor.

The specimen was sent to the Sheffield University Pathological Depart-ment ; Dr. H. W. Gleave has carefully examined it and given me the following report and microphotograph (*Fig* 281) :—

Specimen received March 16, 1928. At a distance of 8 cm. above the ileocæcal valve the ileum shows an acute kink, and from the antimesenteric border a huge diverticulum is given off. Proximally this is of the same diameter as the ileum, but it enlarges at first gradually and then abruptly into a large pouch as seen in the sketch. The length of the diverticulum is 56 cm., the greatest diameter 17 cm., the circumference 50 cm. The upper end is blunt and closed. There is a smooth peritoneal coat except posteriorily, where there is a mesentery carrying blood-vessels and containing fatty tissue. There is also a small amount of fat visible beneath the peritoneum of the diverticulum. Near the lower end a lateral anastomosis to the sigmoid colon has been made. The contents consist of brown fæces of the con-sistency of putty. The inner aspect shows a smooth mucous membrane with no local thickenings. There is no valve at the junction of the diverticulum and ileum.

Microscopically, sections from various parts show the structure of a Meckel's diverticulum. There is a low mucous membrane with glands, resembling that of the small intestine, a muscularis mucosæ, and circular and longitudinal muscle coats. Except for great hypertrophy of the muscle, especially the circular muscle, the appearance exactly corresponds with that of a Meckel's diverticulum 12 cm. long from the Museum. Scanty lymphoid tissue is present in the mucosa. No nodules of pancreatic tissue are seen. A comparison with sections of the wall of the ileum shows that both muscular coats of the diverticulum are in general about five times the thickness of those of the ileum. (The specimen was fixed by distension in formol saline.) The only pathological feature found is in the mucosa, where the blood-vessels are engorged and there is a small amount of lymphocytic infiltration.

COMMENTS.

In a survey of the available literature I have been unable to find any description of a Meckel's diverticulum of such dimensions as the one described above. Philip Turner[1] in 1906 collected 360 cases of Meckel's diverticulum, but not one was of large size. They conformed to the well-known varieties. Bilton Pollard[2] describes a Meckel's diverticulum of remarkable length, 36 in., but it had roughly the same diameter as the ileum from which it arose, and fell into the group of cases formerly recorded under the heading of 'duplica-tion of the intestine'. It is possible that a case similar to the one I have here recorded has been described before, but if so, I have failed to find it in the voluminous literature which has been written on this interesting congenital abnormality. Several writers on this subject have described instances of Meckel's diverticula possessing club-shaped ends (e.g., Klemp). J. Playfair McMurrich and F. F. Tidesdale[3] describe a diverticulum arising from the terminal ileum at its mesenteric attachment and ending in the region of the hepatic flexure of the colon in a bulbous-ended expansion 10 by 6 cm. in

diameter. The proximal tubal part, however. is of the same diameter as the ileum and 104 cm. in length. In discussing the formation of the unusual types of Meckel's diverticulum, the writers make the suggestion that they may represent the entire yolk sac. They suggest that when the primary loop of the intestine returns to the abdominal cavity during the early period of embryological development it may, in very rare instances, drag with it the vitelline duct and the entire yolk sac. It may be that this is the explanation of the origin of the large diverticulum I have described above—in other words, the diverticulum may be the entire yolk sac.

Neither pancreatic tissue nor gastric mucosa was found in the areas of the wall examined by Dr. Gleave. This may be due to the fact that these, if present at all, were in portions of the wall not microscopically examined. According to Schartz,[4] pancreatic tissue is found in only 10 per cent and gastric mucosa in 16 per cent of cases examined carefully.

If I should ever meet such a case again—which is unlikely—I feel that the best treatment would be to divide the communication between the diverticulum and the terminal ileum and drain the sac through a stab-opening in the loin posteriorly. The drainage even then would be slow and would probably need the help of lavage. A permanent mucous fistula might ensue, but I do not consider that any form of internal drainage by anastomosis would drain effectively a Meckel's diverticulum of this type.

I wish to express my sincere thanks to Dr. Gleave for his pathological report on the specimen and for the microphotograph ; to Mr. Chisholm for his kindly help ; and to Miss E. M. Wright for the excellent painting.

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STRANGULATED INTERNAL HERNIA
IN A RETRO-APPENDICULAR PARACÆCAL POUCH.

BY CHARLES DONALD,

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MUCH discussion has taken place over the various pericæcal peritoneal fossæ and their development, and even more over the question of their liability to cause strangulation of gut. Most interest centres on the ileo-appendicular pouch (the inferior ileocæcal of Treves and others), as it is difficult to conceive how such a small fossa could snare gut—the ileocolic is always too small to do so and is only of anatomical interest; and while there are authentic cases recorded by Nasse[1] and Riese[2] of strangulation of short portions, other cases in which large loops have been reported as incarcerated seem less possible.

The case to be recorded discloses another pouch in the same location formed by lack of fusion between the mesocolon and the posterior parietal peritoneum in the terminal stage of embryological rotation of the intestine. Its size and its capability of becoming larger by distension from within, possibly throw some light on these large herniæ which, without the advantage of a post-mortem dissection, have been termed ileo-appendicular. I can find no previous description of this fossa. An additional interest is to be noted in the presence of a 'retroperitoneal' position of the vermiform appendix.

CASE REPORT.

A man, age 57, was admitted to the London Hospital in September 1928, with a history of four days' abdominal pain originating in the . . but shifting later to the right iliac fossa. Vomiting, at first bilious and then stercoraceous, was frequent. An accurate history of bowel movements was not procured.

ON EXAMINATION.—The patient was . . the pulse 140, and the temperature 100·5°. The abdomen was . . with no rigidity except in the right iliac fossa, where moderate resistance was accompanied by some deep tenderness and an indefinite lump was palpable. A diagnosis of acute obstruction of the small intestine was made.

OPERATION.—At operation congested and moderately distended small intestine was traced to an opening behind the ileocæcal junction, where both entering and leaving loops could be detected. The lower small intestine, cæcum, and large gut were collapsed. Fully a foot of small intestine was easily withdrawn from the opening and was found to be moderately congested and dilated, with well-marked constriction rings at either end. The loop quickly regained its colour and the constriction rings also seemed capable of spontaneous recovery. The operation was then finished as quickly as possible. The patient died two hours later.

POST-MORTEM FINDINGS (Figs. 282, 283).—The hernial pouch, measuring 10 by 9 cm. in the collapsed state, lies to the inner side of the ascending colon just above the ileocæcal junction and external to the line of attachment of the mesentery proper. The anterior wall of the sac is transparently thin and vascular and has fused to it posteriorly the appendix, which points spleenwards. The ascending colon, although
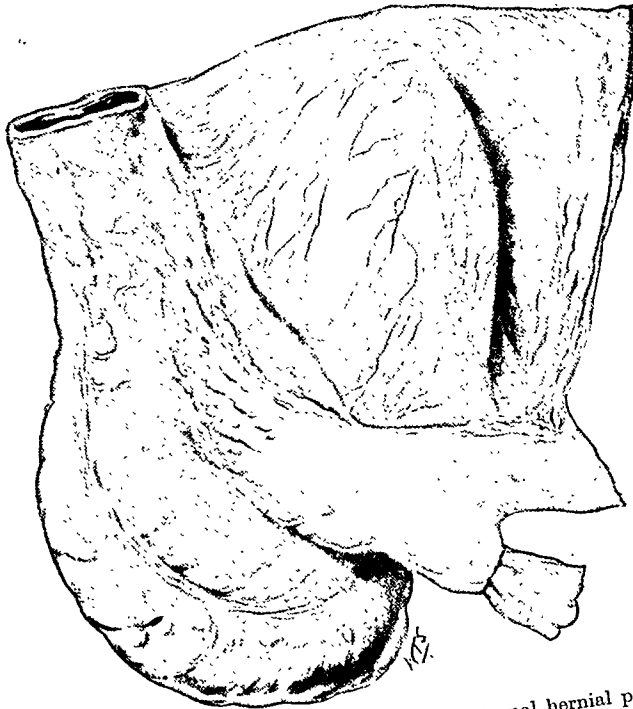
FIG. 282.—Post-mortem specimen showing the internal hernial pouch which has been distended with cotton-wool introduced through the opening seen in *Fig. 283.* The tip of the appendix can be detected showing through the anterior wall. The specimen has been spread out and the attachment of the mesentery proper does not show, being further to the left.
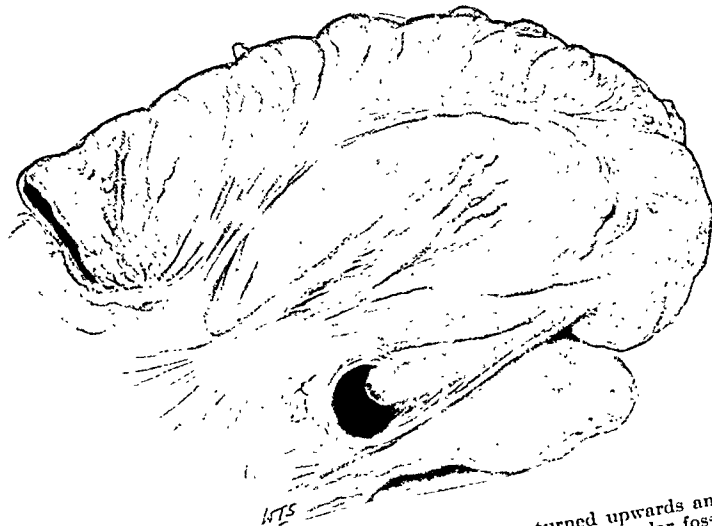
FIG. 283.—The cæcum and terminal ileum have been turned upwards and to the left to display the entrance to the sac. The opening of the ileo-appendicular fossa proper can be seen as the more darkly shaded part below it.

fixed by its inner border so that the pouch never becomes retrocolic, is otherwise free posteriorly, allowing colon and cæcum to be turned upwards and to the left, as in *Fig.* 283, to disclose the hernial opening. The opening (1·5 cm. in diameter) has for its anterior margin a straight fold passing from the cæcum at the base of the appendix to the parietal peritoneum of the iliac fossa. The posterior margin is a crescentic fold attached below to the anterior fold and above to the appendix about two inches from its base.

An ileo-appendicular fossa admitting two fingers is also present, the ileo-appendicular fold running from the terminal two inches of ileum to the appendix itself in so far as that process is outside the sac (*see Fig.* 283), and then losing itself on the anterior margin of the hernial opening. This fossa is funnel-shaped with a wide entrance, and the walls are overladen with fat of little strength.

Further dissection shows that the posterior wall of the sac supports only a few fine vessels, being relatively avascular compared with the anterior wall.

The loop of intestine which had formed the sac contents was found to be sixteen inches long and derived from the ileum about five feet above the ileocæcal valve. It was marked at one end by a distinct and at the other by a rather indistinct anæmic constriction, and showed ill-defined areas of hæmorrhage with some fibrinous peritonitis. There was collapse of intestine below this and distension above.

COMMENTS.

The paracæcal peritoneal fossæ described by Lord Moynihan[3] in his classical work on retroperitoneal hernia are the ileocolic and ileo-appendicular fossæ (the superior and inferior ileocæcal fossæ of Treves and others), the retrocæcal fossa, the fossa of Hartmann, and the fossa iliaco-subfascialis. Rendle Short,[4] in collecting cases subsequently reported, has described another form with the opening on the outer side and the fossa behind the cæcum. Neither mentions the fossa here discussed. The most similar description is Lockwood and Rolleston's[5] previous description of an ileocæcal fossa which they found frequently situated behind the angle of junction of ileum and cæcum, running for a varying distance upwards behind the ileocolic junction and parallel to the ascending colon. So far the description tallies, but then they go on to give its right boundary as the mesentery of the ascending colon and its left as the mesentery proper, and say that it is frequently complicated by two folds, the mesentery of the appendix and the ileocæcal fold. It is obvious therefore that they were describing a larger form of the ileo-appendicular fossa, and thus Lord Moynihan has grouped their ileocæcal fossa as such.

The genesis of the fossa here described is apparently failure of fusion of the ascending mesocolon with the parietal peritoneum in the terminal stage of rotation of the gut. Its formation is therefore similar to that of an inter-sigmoid fossa on the left side. According to Frazer and Robbins[6] fixation of the mesocolon, in a general way, spreads peripherally. In this instance it has been interrupted, probably by the position of the appendix. It is likely then that the hernial opening was kept patent by the pull of a cæcum always changing in volume and that this stress has also given rise to the firmness of its margins. The interrupted process is much less common than the state in which fixation stops short, the latter leading to the terminal ileum and ascending colon being on a common mesentery and thereby predisposed to volvulus.

Stich[7] has described a strangulated hernia in the ileo-appendicular fossa in which two metres of gut were implicated. The diagram he gives from his

impressions at operation reveals a pouch in the same position as the one just recorded, only larger, which he describes as lying in a cavity somewhat above the cæcum between the vermiform process and the ileocæcal junction. It would seem very unlikely that an ileo-appendicular fossa should dilate to such a capacity, and although the appendix in his case was not within the sac there is no reason why failure of peritoneal fusion should not be the more probable cause of such a large pouch.

The case also furnishes an example of a 'retroperitoneal' appendix, and it is interesting to speculate on the ready-made limitation of any effusion should acute appendicitis ever have occurred, which advantage might have been counterbalanced by the difficulty of finding the offending organ.

SUMMARY.

A retroperitoneal fossa lying in the ileocolic angle is described. It is distinct from the ileo-appendicular fossa, which is also present. It contains the appendix adherent to its anterior wall and at operation also contained sixteen inches of strangulated small intestine. Its probable origin is the result of interruption of fusion between the ascending mesocolon and the posterior parietal peritoneum in the last stage of embryonic rotation of the mid-gut.

It is suggested that the larger retroperitoneal herniæ of this region may have been previously wrongly ascribed to the ileo-appendicular fossa whilst actually occurring into the one described.

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LATENT GAS GANGRENE INFECTION.

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THE following cases are considered worthy of record, not only in view of their rarity, but also because of the prolonged and interesting histories, with peculiar clinical findings, and the ultimate onset of acute gas gangrene many years after the receipt of the original wound. All the patients were wounded soldiers, and the histories have been obtained from their medical record cards.

Case 1.—F. E. C., admitted on June 13, 1926, sustained a shrapnel wound of the right tarsus in September, 1917. The metal was removed and the wound cleaned by operation, but a sinus persisted. Operations in April and October, 1918, for the removal of necrosed bone failed to promote healing, and in May, 1919, a Syme's amputation was performed. The wound, after healing by first intention, broke down, and this ulceration healed and recurred so persistently that the wearing of an artificial limb was impossible. In March, 1920, the limb was amputated below the knee. From that time the patient had continual pains in the 'phantom' limb, with occasional cramp-like pains in the thigh. To relieve the pains he had had four operations for the removal of neuromata and shortening of nerves in the stump, and on each occasion, after apparently healing by first intention, the wounds broke down in part, and although there was very little discharge they took one to two months to heal. From 1921 an artificial limb had been worn at intervals with discomfort; on two occasions ulceration over the head of the fibula occurred, probably owing to pressure by the artificial limb.

ON ADMISSION.—The patient complained of pains referred to the ankle, with sensation of clawing of the toes, and occasional cramp-like pains in the thigh. He had not worn an artificial limb for four months.

ON EXAMINATION.—The right leg had been amputated below the knee—stump 7½ in.; amputation and other operation scars were well healed, painless, and not adherent; the head of the fibula was very prominent, and a small scar on the outer side showed evidence of recent ulceration. A definite tender neuroma of the internal saphenous nerve was present about four inches below the knee-joint, and one on the external popliteal nerve behind the tendon of the biceps. Although he complained of pains in the thigh, he could not point to a definite site, nor was there any single tender spot. The groin glands were not enlarged. Clinically and radiographically the spine and pelvis, the sacro-iliac, hip-, and knee-joints were normal, and there was no evidence of any bone disease in the thigh or stump. The central nervous system was normal, the Wassermann reaction negative, and the urine free from albumin and sugar.

OPERATION (Sept. 1, 1926).—After allowing complete subsidence of inflammation over the head of the fibula, operation was performed, the prominent part of the head of the fibula being chiselled away ; the neuroma on the internal saphenous nerve was removed and the nerve avulsed. The external and internal popliteal nerves were dissected up to their separation from the great sciatic about four inches above the knee, and divided. All wounds healed by first intention.

SUBSEQUENT HISTORY.—Three weeks later the patient again complained of pains in the popliteal space and also referred to the foot. On commencing to wear an artificial limb considerable swelling occurred in the popliteal space, or more particularly that area between the upper limit of the bucket and the lower margin of the thigh corset of the artificial limb. This swelling was peculiar ; there was no inflammation or tenderness, it was not brawny, nor did it pit like an ordinary œdema. The sensation was rather like that of palpating the fairly well distended bladder of a football. It occurred after wearing a limb about half an hour, and persisted till the artificial limb was left off, when it gradually dispersed.

On Nov. 9, 1926, that is, about two months after the operation, the wound in the popliteal space broke down, and although there was no discharge the sinus persisted for about two weeks.

SECOND OPERATION (Dec. 4, 1926).—In view of the persistence of the pain, a further operation was performed. The scar in the popliteal space was excised, but apart from a few thrombotic veins, which were removed, nothing to account for the pain could be found. This wound healed by first intention, but, as on the previous occasion, pain and swelling again recurred on commencing to wear the artificial limb. A period of complete rest for four weeks was given, but without producing any alteration in the condition. Amputation above the knee was therefore advised, and the operation performed on March 5, 1927, the limb being amputated at mid-thigh. At the operation the muscles in the posterior flap were noticed to be of a peculiar blue-grey colour.

Apart from slight pain in the stump, the patient was quite well for two days, and on the morning of March 7 the stump was examined, appeared to be satisfactory, and there being practically no discharge the drainage tube was removed. In the evening, however, the patient complained of increasing pain in the stump and also in the right iliac fossa. The temperature was 99·2° and the pulse 106. Examination of the stump showed it to be swollen and discoloured, and definite crackling was present which also extended to the abdominal wall over the right lower quadrant. The stump was opened up and much gas escaped. Free incisions were made into the crackling areas in the abdominal wall, but the patient's condition rapidly deteriorated, a typical text-book description of gas gangrene ensuing. He died at 3 a.m. on March 8.

A complete section of the tissues of the thigh, from skin to bone, was removed immediately after death and sent for examination.

PATHOLOGICAL REPORT.—" The sections show thickening and narrowing of arterial vessels with fibrotic change marked in the middle coat—in one vessel a very early organizing thrombosis can be seen. A large nerve-trunk

shows a marked intra- and interstitial destruction of many nerve-fibres. Muscle shows no change therein at certain areas, while at others there are varying degrees of degeneration to complete loss of histological structure. A separation of tissue elements at such degenerated areas with what are probably gas bubbles is also seen. This condition seen in the muscle is due to the proliferation and extension of a Gram-positive short and medium length bacillus in which spores are not seen—later proved to be *B. aerogenes capsulatus.*

" Cultures show the presence of two Gram-positive bacilli that produce spores : (1) A strict anaerobe *B. aerogenes capsulatus,* (2) *B. mycoides,* which grows aerobically and anaerobically. Whether the latter was present within the tissues is not certain."

Case 2.—A. H. J., admitted on July 8, 1927, received a gunshot wound of the right arm in September, 1917. Two days later operation was performed for excision of the wound and removal of metal. Ever since he was wounded the patient had had pains in the arm of a vague cramp-like character. In 1920 he had a sudden onset of diffuse swelling of the arm which was diagnosed as an internal hæmorrhage. Since that time he had had many similar attacks, the extent of the swelling varying, and frequently being produced by only a slight flexion of the elbow. The condition had been diagnosed as myositis ossificans, and the patient was given a leather support encasing the whole arm from the shoulder to wrist and fixing the elbow. He had had the following operations :—

1923.—Large spur of bone removed from the humerus ; the muscle tissue was fibrotic ; microscopic examination confirmed this and also calcareous deposits.

August, 1926.—Medulla of the humerus opened ; no pus found.

April, 1927.—Vessels in the arm explored; found normal; periostitis present.

June, 1927.—Two spurs of bone projecting into the triceps removed.

Having just left hospital in Leeds after this last operation, the patient was travelling by train to London, when the arm suddenly commenced to swell. He left the train at Birmingham and was admitted to the Highbury Hospital. He complained of severe pain in the upper arm, and numbness and tingling of the hand and fingers.

ON EXAMINATION.—There was diffuse swelling of the right upper arm, extending a short way below the elbow ; general tenderness, but no single maximum point. There was no discoloration suggesting hæmorrhage, and the swelling did not pit as an ordinary œdema. Wrist, finger, and shoulder movements were complete. Temperature 99·2°, pulse 88. Nothing abnormal was discovered in the heart or lungs; the blood-pressure was—systolic 138, diastolic 78 ; coagulation time, normal. The central nervous system was normal; Wassermann reaction negative. X rays showed thickening of the middle third of the humerus with some rarefaction and slight periosteal irregularity on the anterior surface, with two small opaque nodules in the area of the biceps, suggesting calcified or bony spicules.

SUBSEQUENT HISTORY.—The arm was slung up vertically and a firm

bandage applied. The swelling gradually subsided, and at the end of a week the arm was practically normal; no discoloration suggesting hæmorrhage occurred.

OPERATION (July 20, 1927).—The humerus was exposed by incisions on the outer and inner aspects. All bony irregularities were removed from the shaft, restoring its normal cylindrical shape. An opening was trephined into the medullary cavity at the site of rarefaction suggested on X-ray examination, but no pus or granulation tissue was found. The biceps muscle appeared fibrotic, particularly in its upper outer aspect, and the anterior three-quarters of the muscle was removed. The brachial artery was examined and found to be occluded in its lower half. Small drains were provided in each wound. The removed portion of the biceps muscle was sent for examination.

Next day the patient's condition was satisfactory, the temperature 99·8° and the pulse 88. Some swelling of the forearm and hand was present, and the circulation was rather sluggish. The following day the patient's condition remained the same; there was considerable discharge of a dark grumous material from both wounds.

On July 23 the patient's condition was deteriorating, the temperature being 100·2° and the pulse 100. There was diffuse swelling of the limb, the skin of the upper arm was discoloured, and there was a profuse discharge of gas bubbles with grumous material from the wounds.

SECOND OPERATION (July 23, 1927).—Under gas and oxygen anæsthesia the arm was disarticulated at the shoulder and the incision continued to the lateral wall of the chest through the crepitant area, and carried through the serratus magnus and latissimus dorsi muscles, which were of a dark grey colour in part. The deeper muscles of the chest wall appeared normal. The extensive wound was left open and packed with gauze soaked in saturated solution of magnesium sulphate. A section of the tissues from the arm was sent for examination.

The patient was given 40 c.c. of anti-gas-gangrene serum and salines intravenously. Further injections of 40 c.c. of anti-gas-gangrene serum were given on the subsequent two days and 20 c.c. on each of the next two days. The patient developed a septic parotitis which required drainage, and his convalescence was protracted. The wound very gradually cleaned up and healed. The patient was discharged on Oct. 7.

PATHOLOGICAL REPORTS.—Muscle removed on July 20 :—

" One part of the surface was dark, and on section showed recent and some old hæmorrhage, with small proliferation of fibrous tissue and congestion of small vessels. The deeper section showed a slight tendency of intramuscular connective tissue to proliferate and rare foci of infiltration of small round cells at sites of vessels. Three nerves at the more superficial part showed marked interstitial neuritis, most fibres being replaced by fibrous tissue. At the piece of hæmorrhagic surface two or three Gram-positive rods were noted."

Muscle removed on July 23 :—

" Tissue consists entirely of muscle tissue in which numerous areas of necrosis are seen. In and around these areas of degeneration there is a heavy infection with bacilli that are most probably of the gas-gangrene group."

The following two cases are also considered worthy of inclusion in this report because of their clinical resemblance to the foregoing cases, suggesting a similar condition, although it was not definitely established.

Case 3.—W. H. S., admitted on April 13, 1928, received a gunshot wound of the right thigh in 1916, with injury to the great sciatic nerve. This had been sutured, a portion of the fascia lata removed from the outer side of the thigh being sutured round the nerve. An excellent recovery of the nerve had taken place, but the patient had always had aching pains in the thigh, with attacks of swelling, the thigh feeling at times ' as if it would burst '. In 1921 a small localized swelling had appeared on the outer side of the thigh, and this had gradually increased. He was admitted because of this and on account of his pains, which were increasing in frequency and severity.

ON EXAMINATION.—The patient had an extensive scar down the back of the thigh, adherent to the underlying muscle. A large muscle hernia was present on the outer side of the thigh where the fascial strip had been removed. Just above the muscle hernia a sensation as of gas crepitus was present. Clinically and radiographically there was no evidence of any bone disease, nor of arthritis of the hip- or sacro-iliac joints. He had no paresis or sensory defect ; reflexes were normal and the Wassermann reaction negative. X rays did not show the presence of gas bubbles in the tissues.

OPERATION (April 18, 1928).—Operation was performed to cure the muscle hernia. This was done by enfolding the muscle upon itself, the fascia being overlapped over this.

SUBSEQUENT HISTORY.—Three days after operation the patient complained of increased pain in the thigh. On examination of the wound small bubbles of gas were observed issuing from it. He was given 40 c.c. of anti-gas-gangrene serum. The wound oozed for a short time, but it was quite healed in three weeks. The patient was seen six months later. There was no recurrence of the hernia, but the pains and sensation of fullness of the thigh persisted. In view of this he was re-admitted and on Oct. 3 the sciatic nerve was explored. It was found bound down by fibrous tissue, which was removed and the nerve stretched. Prior to this operation the patient was given 10 c.c. of anti-gas-gangrene serum after desensitization. The wound healed without trouble. This operation relieved the pains in part, although he still had attacks at times, accompanied by a sensation of fullness of the thigh.

Case 4.—J. H. J., admitted on Feb. 4, 1929, had received a gunshot wound of both buttocks in 1917. The wounds discharged for a considerable time, finally healing in March, 1918. Since then he had always had aching pains in the buttocks, chiefly the left, which at times became swollen and felt ' tight '. In 1923 he had a more severe attack of pain and the buttock became swollen ; the wound broke down, but practically no discharge occurred. The ulcer took five months to heal. Two months prior to admission a similar attack commenced, and the wound broke down two weeks later.

ON EXAMINATION.—An extensive transverse scar was present on each buttock, just above the gluteal fold. There was considerable loss of tissue of the left buttock, the scar in which was dense and depressed, and had in its

centre a deep ulcer from which there was practically no discharge. A probe could be passed forwards one inch. Slight tenderness was present just above and behind the left great trochanter, and the impression given here was as of palpating a sponge. Clinically and radiographically the spine, hip-, and sacro-iliac joints were normal. Rectal examination was negative and the Wassermann reaction negative. X rays showed an absence of any foreign body in this buttock; a small superficial foreign body was present in the right buttock.

The patient was given 10 c.c. of anti-gas-gangrene serum. The swelling soon subsided and the ulcer gradually healed; at no time did any discharge occur.

COMMENTS.

The outstanding features in the foregoing cases are the long history of vague cramp-like pains without definite localization; the periodic swellings of peculiar type; the repeated breaking-down of scars with prolonged ulceration without discharge; the previous operations without gross untoward consequences; and in *Cases* 1 and 2 the onset of acute gas gangrene almost ten years after the initial wound.

At no time in any of the cases did X rays show gas bubbles present in the tissues; this is of interest, because in several other cases where such bubbles have been shown, operation in the affected area was not followed by any untoward results.

The explanation suggested is that a nidus of organisms of low virulence existed in the muscles of the part. The activity of these organisms being mild, small portions only of a muscle would be irritated, and this unequal contraction might account for the cramp-like pains complained of, any gas produced being of such small quantity that it was readily absorbed. When the focus became stimulated, as by excessive use of the part, or external irritation, or by the laceration of tissues in its neighbourhood by operation, or, as in *Case* 2, by the bony or calcareous spicules, the activity would be greater, and the tension of the collecting gas might become sufficient to cause any weak scar to give way; this ulceration would persist till the activity subsided. The onset of the acute gangrene in the first two cases would follow upon the production of an optimum medium for the organisms by the much greater destruction of muscle, especially if the actual nidus had been cut through, as, from the pathological reports, would appear to have happened in *Case* 2.

PERI-ARTERIAL SYMPATHECTOMY :

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF THIS OPERATION UPON LOCAL CIRCULATION.

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ALTHOUGH Leriche and his pupils have done much experimental work, at the present time peri-arterial sympathectomy may be described as an empirical operation, since its performance is based almost entirely on the favourable results observed clinically in certain cases to which it has been applied. In some parts of Europe the operation is enthusiastically performed for a great variety of conditions ; elsewhere surgeons look upon it with less enthusiasm, while most anatomists and physiologists regard with some astonishment the claims of its most ardent advocates. It therefore appears desirable to attempt to obtain some experimental evidence for or against the procedure. Is the operation merely a surgical fashion of the moment, or has it any underlying scientific basis to justify its performance for conditions in which it is desirable to increase the vascularity of the periphery of the limb ?   In order to decide this question it is in the first place advisable to consider the usual method of performing the operation on man, because it is obviously necessary to simulate as closely as possible the conditions obtaining in human surgery before drawing deductions from any experimental work on animals.

The Operation on Man.—As performed in man, peri-arterial sympathectomy is most often applied to the femoral artery, from which a cuff of adventitia is destroyed, either by peeling it off the vessel,[1, 2] infiltrating it with alcohol,[3] or painting it with phenol.[4]   The operation is also performed on the popliteal, the subclavian, and the brachial arteries, and by certain surgeons on the carotids, the abdominal aorta, and the iliac vessels.   In but few instances has it been carried out upon more peripheral vessels.

The chief problem presented to us was to see whether we could obtain any experimental evidence of increased peripheral vascularity following performance of the operation upon the femoral, the femoral together with the popliteal, and the carotid arteries of animals.

Animals Used.—For the investigation we decided to use cats and albino rabbits.   The vasomotor reactions of the cat are easily elicited, and from the experimental standpoint are already known in some detail.   Furthermore, the size and structure of their arteries make the operation of peri-arterial sympathectomy technically possible.   Albino rabbits were used because changes can be easily observed in the conspicuous vessels of their large pale ears.

Nature of Experiments.—Four types of experiment have been attempted:—

1. Following peri-arterial sympathectomy of one femoral artery of the cat, inert dye substances were injected into the peripheral vascular system, and, subsequently, in order to determine the distribution of the dye in the vessels, a post-mortem histological examination of corresponding parts of both hind limbs was carried out. After performing a few of these injection experiments it was decided to abandon them for others better designed to afford information of the vascular system of the limb.

2. Following the work of Hunt,[5] Dale and Richards,[6] and Burn and Dale,[7] certain substances, such as acetyl choline, histamine, and adrenalin, known to act on the arterial and capillary systems, were used to differentiate the responses of normal limbs and those upon which peri-arterial sympathectomy had been performed.

3. The rate of blood-flow through normal limbs and through those upon which the operation had been performed was compared in a further series of experiments by estimating the heat production in each limb by a calorimetric method.

4. The state of the circulation in the ear of the albino rabbit being readily apparent, experiments were carried out to ascertain the effect of the operation when performed upon the arteries supplying the ear.

The Actions of Acetyl Choline, Histamine, and Adrenalin upon the Blood-vessels of a Limb following Peri-arterial Sympathectomy.—Heretofore no attempt appears to have been made to ascertain the response to the above substances of a limb upon which peri-arterial sympathectomy has been performed. Hunt has shown that acetyl choline is a powerful dilator of arterioles and capillaries, while Dale and his collaborators have shown that in the cat histamine is a dilator of capillaries and a constrictor of arteries. Acting on the assumption that a vessel already dilated is incapable of giving a dilator response as great as that capable of being elicited from a more constricted vessel, we have used these substances to assess the condition of the circulation.

Changes in the calibre of vessels in the limb have been measured as changes in volume by the plethysmograph, the technique adopted being substantially that described by Dale and Richards. The plethysmographs consisted of glass cylinders, 14 in. long and $2\frac{1}{4}$ in. diameter, open at one end, the other end furnished with two small openings, one of which was used for filling the cylinder with water, the other for connecting it to a small float recorder working on a kymograph (*Fig.* 284). An invaginated rubber cuff made a water-tight joint with the limb. We found it necessary to use very thin rubber for this purpose, since while we required a joint that would not leak we had also to avoid undue pressure on the limb with consequent interference with a free circulation. The animal's fur was thoroughly greased with vaseline to add to the efficiency of the joint. The float recorders were of a small cylindrical pattern and of equal dimensions and leverage. In order to check any mechanical errors due to the recorders the tubes connecting them to the plethysmographs were changed over during the course of certain of the experiments. A hollow needle was tied into a fore-limb vein for the introduction of solutions. Blood-pressure was recorded through a cannula tied into the common carotid artery and connected with a mercury manometer

recording on the kymograph. Anæsthesia was maintained by ether vapour delivered through a cannula fixed in the trachea through an opening in its upper rings.

The femoral artery in the cat is easily exposed on the inner (ventral) surface of the thigh in an intermuscular furrow which can be felt extending from the inguinal (Poupart's) ligament along the line of the axis of this part of the thigh. On opening the deep fascia the femoral artery, accompanied by a nerve and a large vein which is usually superficial and overlies the artery, is found embedded in fatty areolar tissue.
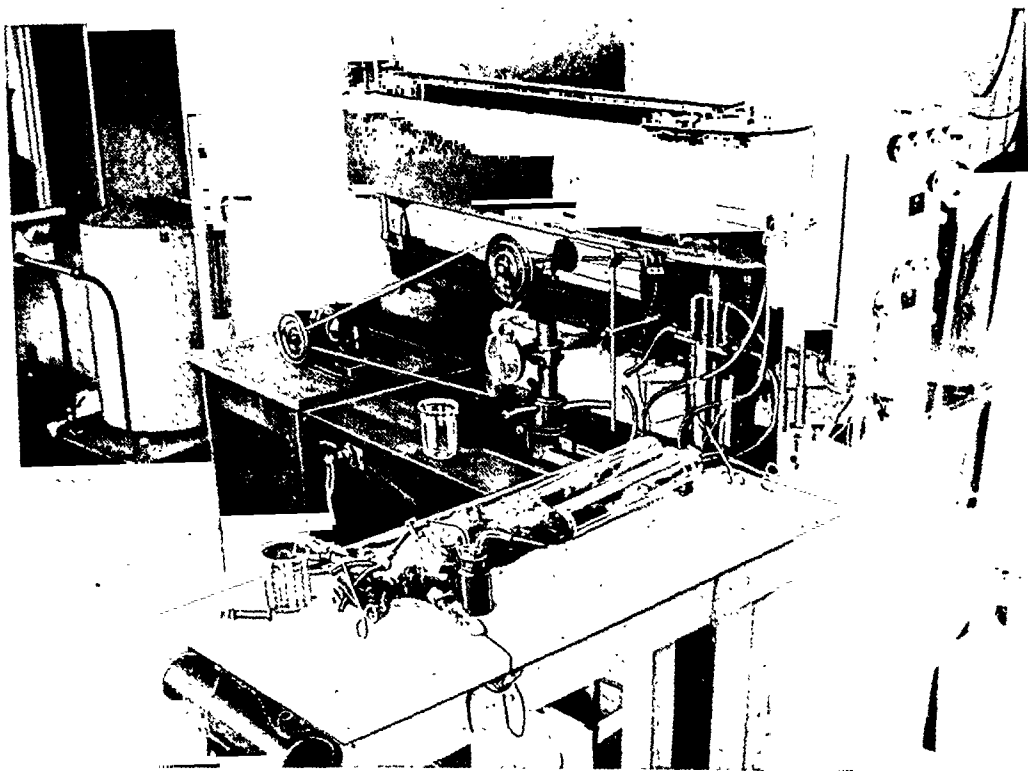
FIG. 284.—Photograph of an actual experiment in course of performance. The apparatus used and the method of obtaining the tracings shown in *Figs. 285-289* are shown.

The Operation on the Cat.—The artery was dissected free, lifted out of its bed, and either carefully stripped of its adventitia for about a centimetre of its length or phenolized by painting it with a fine camel-hair brush dipped in concentrated phenol solution, care being taken not to contaminate the adjacent nerve and vein. In order to avoid this contamination a narrow strip of thin sheet rubber was first placed beneath the artery, and, after well painting the vessel and rolling it first to one side and then to the other so as completely to phenolize its circumference over a length of approximately one centimetre, the vessel was dried carefully with cotton-wool pledgets and replaced in its bed. In some animals the fascia was closed with interrupted catgut sutures, in others there was no separate closure of the fascia. The

skin was sutured with either silkworm gut or catgut, silkworm gut being used in the majority of experiments. In certain experiments one or both femoral arteries were exposed, isolated, and phenolized after the limbs had been placed in the plethysmographs and some preliminary tracings obtained. In these experiments the wounds were protected by saline pads, which were kept moist.

The Effects of Peri-arterial Sympathectomy on the Artery.—In human subjects we have noticed, in confirmation of frequently repeated observations of others, that when the artery is healthy, as in young patients, a localized contraction, slightly greater in extent than the length of vessel stripped, takes place at the site of stripping. If, however, the vessel is sclerosed, no change takes place. In the cat we observed a constriction after phenolization in some animals, in others no change was seen, while in still others, in contra-distinction to the constriction seen in the human artery, a dilatation was noticed. When this dilatation occurred it did not appear to be due to a mechanical weakening of the vessel wall, as we first suspected, because we observed it following phenolization as well as after mechanically stripping the vessel. In no case of stripping were we able to produce the local contraction seen in the human subject, but it was clearly demonstrated after phenolization.

The Popliteal Artery.—We considered that the sympathetic fibres to the vessels might leave the main nerves to the limb at intervals, as these nerves approached the periphery. Woollard[8] has shown that this arrangement exists in the cat, while Blair and Bingham[9] have more recently demonstrated the condition in man.

Because of this arrangement of nerves we extended certain of our experiments, combining stripping or destruction of the network on the femoral artery with similar treatment of the popliteal.

The popliteal artery in the cat is deeply placed in the animal's ham and obscured by the large vein which accompanies it and overlies its dorsal aspect. With a little care we found it possible to expose and isolate the artery through a longitudinal incision in the popliteal space, and, after guarding against contamination of the surroundings of the vessel in the same way as in the case of the femoral artery, to phenolize the vessel over a length of nearly five or six millimetres. The sciatic and external popliteal nerves were well away from the site of phenolization and easily avoided when painting the artery.

The Effects of Peri-arterial Sympathectomy on Local Circulation.—Immediately following the operation there is no obvious change regularly observable in the general circulation of the limb. We have taken note of the colour of the pads of the paws when these were not pigmented, and have noticed that, although normally of a pale colour, in a few cases following the operation a slight flushing or reddening of the pads occurred, indicating a dilatation of the surface capillaries. The paws of the majority of the animals were too pigmented, however, to permit the use of this method of estimating any change in the circulation, and we have therefore made use of the reactions of acetyl choline, histamine, and adrenalin to measure the degree of vascular dilatation following the operation.

Acetyl choline dilates both arteries and capillaries, and following its introduction into the blood-stream there is a fall in blood-pressure owing to

the diminution of the normal vascular resistance. The dilatation of vessels is measured in the plethysmograph as an increase in limb volume. Blood-pressure is rapidly restored to its normal level, apparently in the first place by the action of the vasomotor centre through the vasoconstrictor nerves increasing the tone of the vessels, and secondly by the excretion of the acetyl choline.

.The effect of histamine in the cat is more complex, since there is a double and somewhat paradoxical action, the arteries being constricted but the capillaries dilated. The chief dilatation occurs in the vessels of the skin,
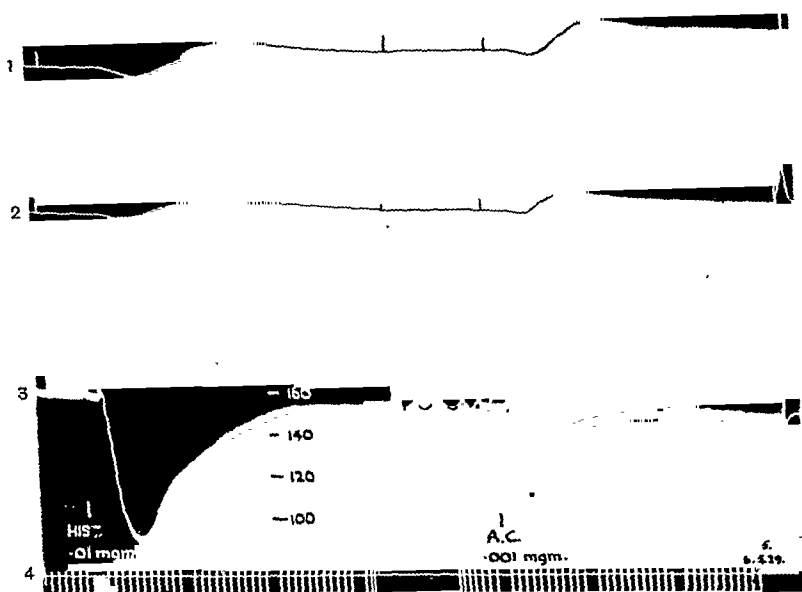
Fig. 285,—Tracings showing limb volume responses and that of the carotid mean blood-pressure to intravenous injection of histamine and acetyl choline. The left femoral artery had been phenolized approximately ten minutes before the record was taken. Reading from above downwards the tracings represent: 1, Right limb volume; 2, Left limb volume; 3, Carotid mean blood-pressure; 4, Time in 5-second intervals.

Owing to vascular dilatation in the limb operated upon there is less response to histamine and acetyl choline in this limb than in the normal limb.

and to demonstrate this opening of vessels as an increase in limb volume, care must be taken to anæsthetize the animal so as to avoid struggling while keeping the anæsthetic fairly light. As little disturbance as possible should be caused to sensory nerve-endings by the various operative procedures. Assuming that these precautions are taken, intravenous injection of histamine is followed by a fall in blood-pressure and an increase in limb volume—the latter evidence of capillary dilatation.

If peri-arterial sympathectomy causes an increased supply of blood to a limb or other portion of the body it can only do so by dilating the vessels.

supplying the part. In consequence, the vessels involved will be unable to give their usual responses to acetyl choline and to histamine, since they are already partially dilated. An experiment in which this possibility was investigated is depicted in *Fig.* 285. The tracing shows records of the volume of the [two hind limbs. The upper tracing is from the right limb, the lower from the left, and shows the volume changes occurring approximately ten minutes after femoral phenolization. Below these two is the record of arterial blood-pressure, and at the foot of the tracing a time record with intervals of five seconds. Following the injection of 0·01 mgrm. of histamine contained in 1 c.c. of saline, there is a transient fall in mean blood-pressure from 155 mm. Hg to 90 mm. Hg. An increase in limb volume occurs a little later than the onset of the blood-pressure fall, owing to the time period required for the transportation of histamine to the vessels of the hind limbs. It is seen that both limbs dilate, but that a greater response is elicited from the normal limb, indicating that the vessels of the other limb are already partially opened up. A similar differentiation in the response of the two limbs to acetyl choline is shown in the second half of the tracing. Such experiments would indicate that dilatation follows peri-arterial sympathectomy, and further support of this is given by the following experiment :—

Fig. 286.—Tracings showing limb volume responses and that of the carotid mean blood-pressure to acetyl choline and adrenalin. The right femoral artery had been phenolized approximately five minutes before the record was taken. Reading from above downwards the tracings represent : 1, Left limb volume ; 2, Right limb volume ; 3, Carotid mean blood-pressure ; 4, Time in 5-second intervals.

Owing to vascular dilatation in the limb operated upon there is a smaller response to acetyl choline and a greater to adrenalin than in the normal limb.

Adrenalin in fairly large doses constricts both arteries and capillaries, causing a rise in blood-pressure, quickly compensated by the action of cardiovascular reflexes. Diminution in limb volume gives evidence of the vascular constriction. In the experiment depicted in *Fig.* 286 the altered response to acetyl choline, which we have already described, was first demonstrated, and following that an injection of 0·1 mgrm. of adrenalin was made. The lower of the limb-volume tracings, that from the limb operated upon, shows a greater diminution in volume. This augmented constrictor effect of adrenalin was to be expected if the limb vessels had undergone dilatation

following the destruction of the peri-arterial network, and it therefore confirms the supposition that dilatation had taken place.

Such experiments as these appear to indicate that peri-arterial sympathectomy is undoubtedly followed by an increased blood-supply to the part. Further experiments, however, have convinced us that such dilatation as occurs is but evanescent. In many experiments we have had difficulty in demonstrating the changed response to histamine or acetyl choline, and in others in which differing responses were present at the commencement, these had disappeared before the termination of the experiment. On two
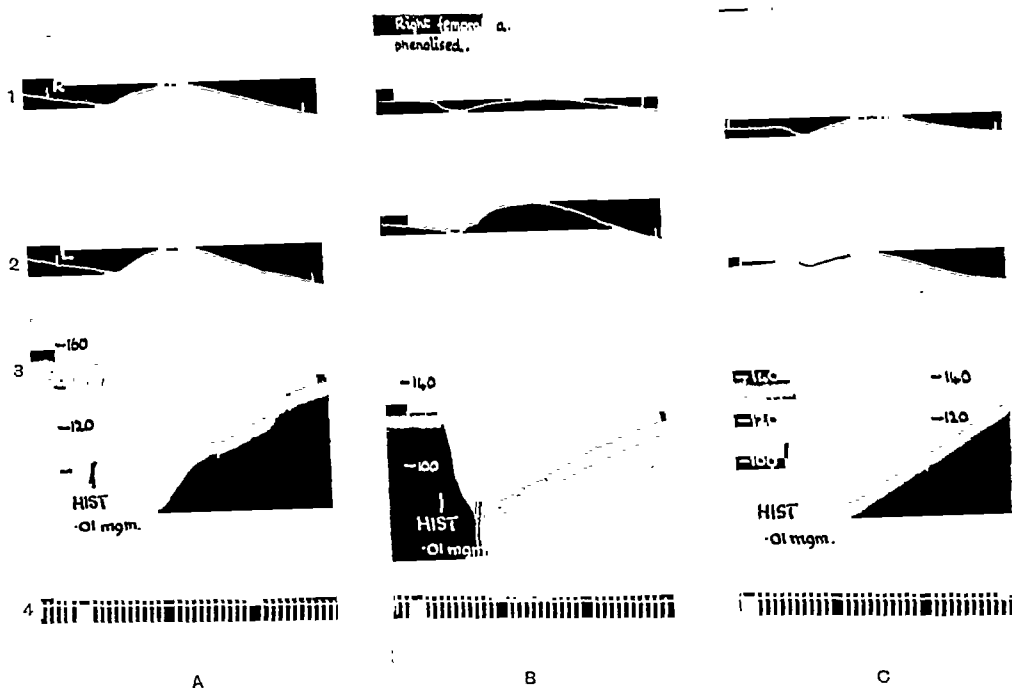
FIG. 287.—Tracings showing limb volume and mean carotid blood-pressure responses to histamine following femoral peri-arterial sympathectomy. In all these records reading from above downwards the tracings represent : 1, Right limb volume ; 2, Left limb volume ; 3, Carotid mean blood-pressure ; 4, Time in 5-second intervals.

A shows the response to histamine when both limbs are normal, B the response *immediately* following phenolization of the right femoral artery (upper tracing), and C the response three minutes after the phenolization. It will be seen that although the histamine dilatation has disappeared in the right limb following immediately upon the phenolization, three minutes later the curves are again parallel as they were at the beginning of the experiment.

occasions, moreover, we have been able to obtain quite definite evidence, showing that the limb-volume changes rapidly disappear. The tracings, A, B, and C in *Fig.* 287 are taken from one of these experiments. Both limbs were placed in plethysmographs and both femoral arteries were exposed and prepared for phenolizing. The reactions to histamine and acetyl choline were then tested and both were found to give a fall in blood-pressure with good limb dilatation. After a brief rest. the right artery was phenolized and the effect of histamine and acetyl choline again measured. The dilatation

previously present in the right limb had disappeared, and there was only a slight preliminary constriction, due in part to a passive following of the reduction in blood-pressure and also to the constricting action of histamine on the arteries. The response to acetyl choline remained practically unchanged. Three minutes were allowed to elapse, and histamine and acetyl choline were again injected. The dilator response to histamine had re-appeared, indicating the regaining of capillary tone.

A similar experiment was then performed upon the left limb. Immediately following the phenolizing of the artery there was a loss
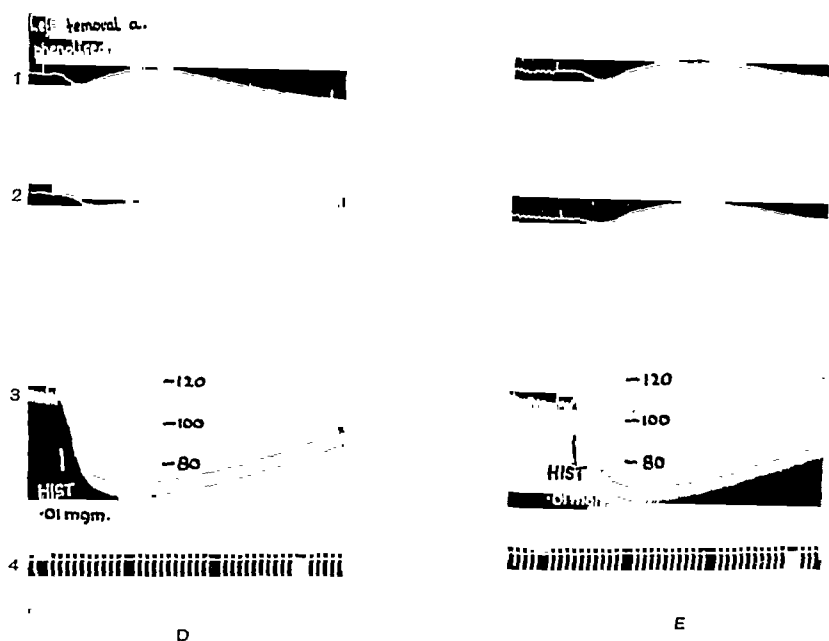
FIG. 288.—The same experiment as in *Fig.* 287. The left artery has now been phenolized. The tracings read from above downwards as in *Fig.* 287. It will be seen in D that the histamine dilatation has disappeared *immediately* following phenolization, but that in E, three minutes later, the curves are again parallel as in A and C (*Fig.* 287).

of capillary tone, shown by the disappearance of the histamine limb dilatation. Within three minutes this was restored (*Fig.* 288, D and E). Finally, as a control, to demonstrate that the actual painting of the arterial wall was not the factor concerned, the right artery was repainted, histamine was again injected, and it was now found that the histamine dilatation had not disappeared.

In the experiments thus far described peri-arterial sympathectomy was confined to the femoral artery. *Fig.* 289 gives an indication of the vascular responses of the hind limb in an experiment where both femoral and popliteal arteries were phenolized. The upper tracing is the left limb which was operated upon. The responses from the two limbs are nearly identical, indicating that any vascular dilatation immediately following the destruction

of the peri-arterial network has disappeared during the thirty minutes which have elapsed since the performance of the operation.

We were therefore led to the conclusion that while in some cases peri-arterial sympathectomy leads to an increased blood-supply, such an increase is only transient.
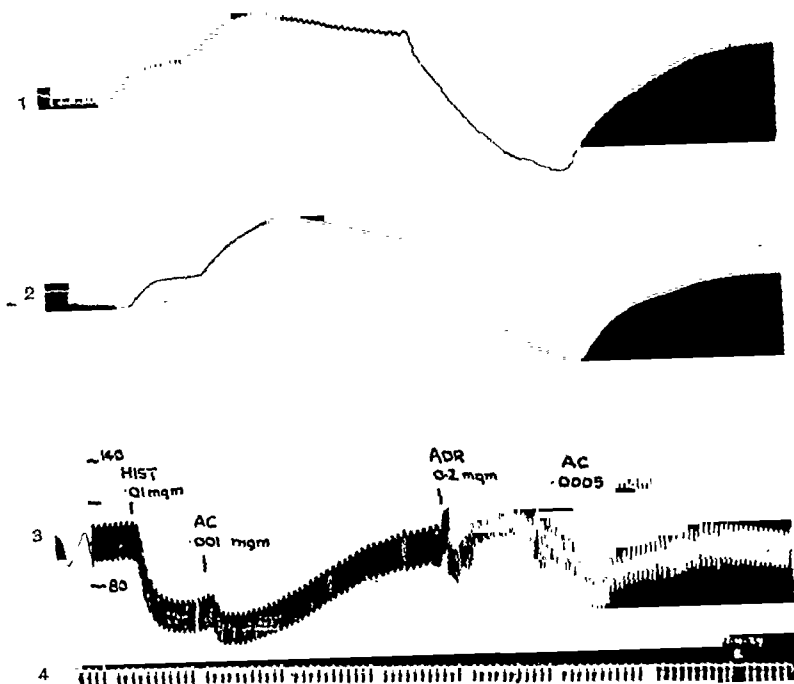
Fig. 289.—*Tracings showing limb volume and mean carotid blood-pressure responses to histamine, adrenalin, and acetyl choline. One limb is intact, the other has been subjected to femoral and popliteal sympathectomy performed by phenolizing these arteries. Reading from above downwards the tracings represent:* 1, Left limb volume (sympathectomized arteries); 2, Right limb volume; 3, Carotid mean blood-pressure; 4, Time in 5-second intervals.

It will be seen that although the main artery of the right limb has been phenolized in two stages of its course, at the time of the experiment, about thirty minutes following the operation, the responses of the two limbs to vascular constrictor and dilator substances are practically identical.

Calorimetric Studies following Peri-arterial Sympathectomy.—Stewart[10] has demonstrated that the rate of blood-flow through a limb may be assessed by measuring its heating capacity by calorimetric methods. Recently Brown and Rowntree[11] in man have measured the heat production of arms and legs following peri-arterial sympathectomy of the brachial and femoral arteries respectively. They report that a fortnight after stripping the artery it was impossible to demonstrate any vasodilatation in the limb.

For measuring heat production we employed two glass cylinders each 14 in. long. These were clamped vertically, and each was closed at the bottom

by a stopper carrying a mechanical stirrer (*Fig.* 290). A thermometer reading to 0·05° C. was introduced into each cylinder through a narrow side tube, junction being made by a small rubber cuff. The anæsthetized animal was held in a sling above the calorimeters so that the hind limbs hung vertically within them. Equal volumes of water, usually 100 c.c. cooled down to 8° C., were poured simultaneously into the cylinders, and increases of temperature recorded at two-minute intervals for twenty minutes. A series of control readings were taken to determine the rate of water heating without the limb.
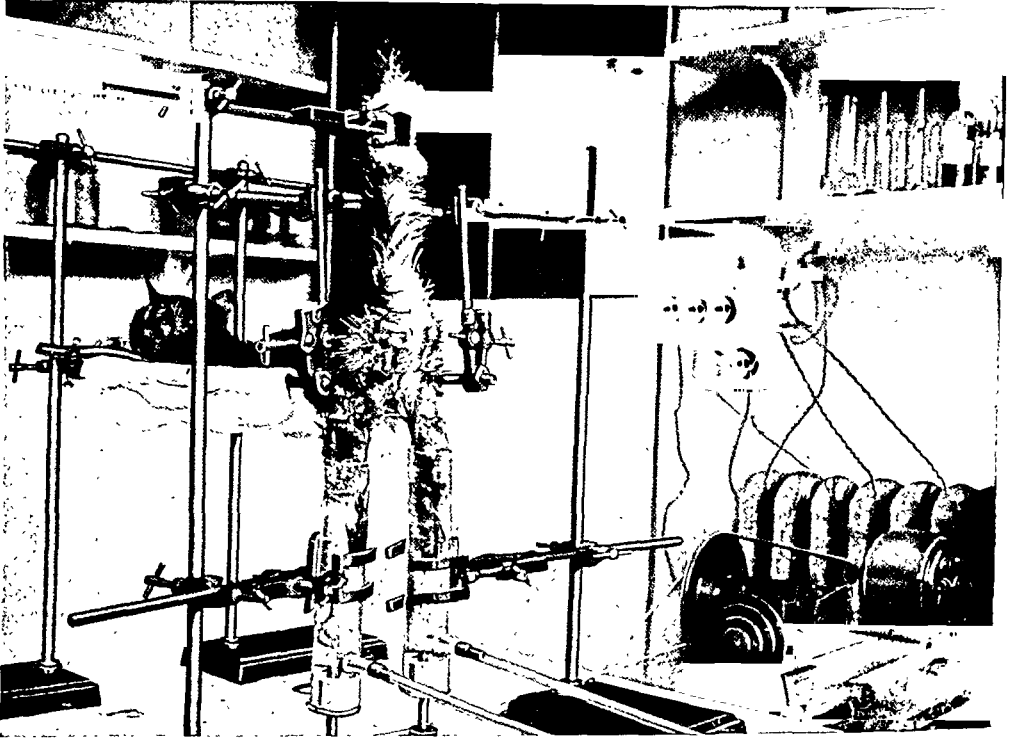
FIG. 290.—Photograph of apparatus used for estimating temperature changes in the limbs following peri-arterial sympathectomy.

Eight cats were examined, and the heat production in the hind limbs was measured at periods varying from a few minutes up to twelve days following the operation. *Figs.* 291 and 292 are tracings from two of these experiments. In no case have we observed any evidence of vasodilatation, the heating capacity of the limb operated upon and of the normal one being identical. In those experiments where the femoral artery was phenolized and the animal permitted to recover, three or four calorimetric records were taken within a fortnight, and afterwards the reactions of the vessels to histamine and acetyl choline were determined as described in the previous section. In four cats which were examined in this manner, the volume responses of the two limbs were identical.

The Effect of Peri-arterial Sympathectomy of the Common Carotid Artery on the Circulation in the Ear of the Rabbit.—The original aim of this series of experiments was to isolate the individual arteries supplying the ear
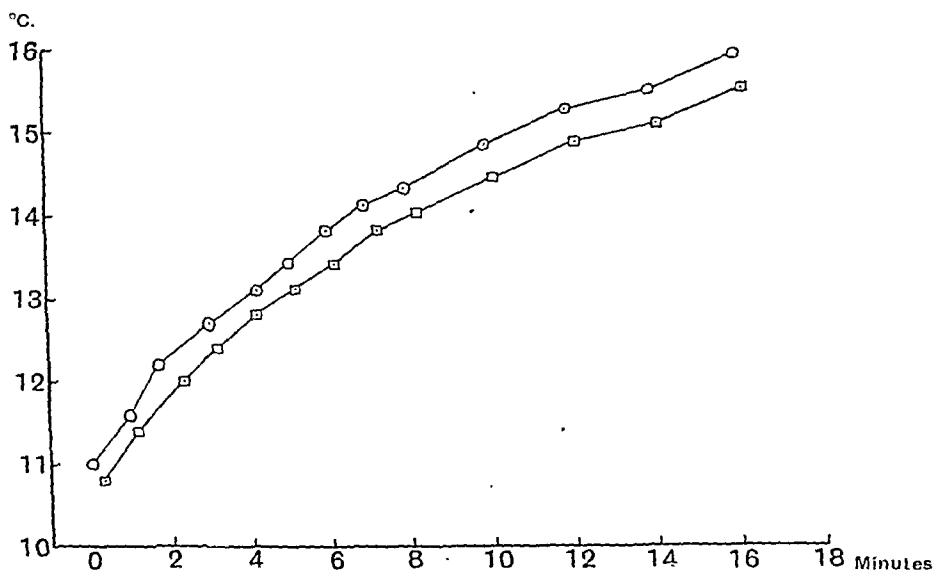
FIG. 291.—Temperature tracings of the hind limbs of a cat subjected to peri-arterial sympathectomy of the right femoral artery six days previously. The lower tracing is from the right limb. Description in text.
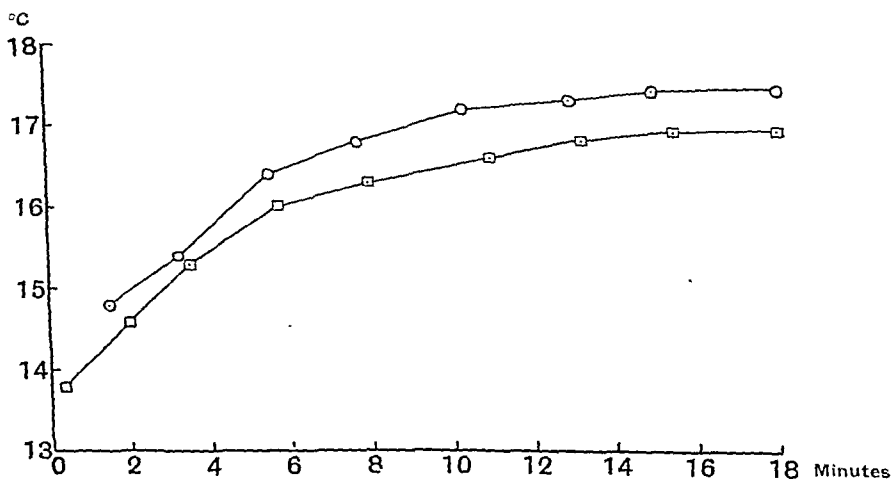
FIG. 292.—Temperature tracings of the hind limbs of a cat subjected to peri-arterial sympathectomy by phenolization of the left femoral artery ten minutes previously. The lower tracing is from the right limb. Description in text. (The left thermometer reads 0·5° C. above the right in all records.)

of the albino rabbit and to destroy the peri-arterial network, but because these arteries are small and technically rather difficult to isolate, we directed our attention, after two abortive experiments on the terminal branches, to

the destruction of the nervous elements situated on the common carotid artery.

The artery was exposed through a mid-line incision extending downwards for about 4 cm. from the level of the thyroid cartilage, the sternomastoid muscle being retracted outwards. The carotid artery was separated from its surrounding structures and isolated upon a thin strip of sheet rubber as pre-

FIG. 293.—Head and ears of albino rabbit six hours after phenolization of tne right carotid artery under ether anæsthesia. The vasodilatation in the right ear is apparent.

viously described for the femoral artery. Taking great care to avoid contamination of its surroundings, the artery was painted with phenol, and after drying returned to its original position. The wound was closed with interrupted silkworm-gut sutures.

No immediate change in the vessels of the ear was noticed in four rabbits treated as above, but six hours after the operation in three of these

rabbits the ear of the side which had been operated upon showed well-marked reddening and was warmer to touch than the other ear (*Fig.* 293). This increased vascularity persisted throughout the next day, but in most of the animals had subsided and disappeared by the end of the second. Three weeks after the first operation the other carotid artery was exposed in each case, and following its phenolization a transient vasodilatation was observed in the ear of the same side, similar to that produced in the opposite ear following the first operation.

One rabbit proved an exception. The left carotid artery was exposed and phenolized, but search was also made for the sympathetic trunk. This was found and stimulated electrically, a constriction of the ear vessels during the period of stimulation being obtained. It would appear that some damage was done to the sympathetic trunk, since ten minutes after the observation the left ear vessels were dilated, and continued so for twenty-four days. At the end of this period the right carotid artery was exposed and phenolized, with a result similar to that obtained in the other three animals, the consequent vasodilatation of the ear being only transient. This and other experiments in which the sympathetic trunk was divided have shown how much better and more lasting is the vasodilatation following division of the main sympathetic cord than that produced by denervation of the carotid artery.

It should be mentioned that vascular reactions in the ears of the rabbit appear to be very easily elicited; thus stimulation with the faradic current of the cervical sympathetic, the carotid artery, or even the skin at the base of the ear, causes the vessels to constrict and the ear to become pallid.

Conclusion.—Although we have noticed individual variations in the reactions of both sets of animals employed for these experiments, the majority gave the results which are here described, and we therefore conclude that peri-arterial sympathectomy does increase the local circulation, but that its effects are exceedingly transient.

SUMMARY.

1. An experimental investigation has been carried out of the effects of peri-arterial sympathectomy in animals.

2. A description of the methods employed for the destruction of the peri-arterial nerve network is given.

3. The effect of peri-arterial sympathectomy performed upon the femoral or femoral and popliteal arteries of the cat has been measured by comparison of the responses to certain substances of the vessels of the limb operated upon with those of the corresponding normal limb.

4. Vasodilatation follows the operation, but is very transient.

5. Comparison of the heat production in the limbs of the cat following the performance of the operation on one side, indicates that no permanent vasodilatation results.

6. Peri-arterial sympathectomy performed upon the carotid artery of the albino rabbit results in a vasodilatation of the corresponding ear lasting for about forty-eight hours and then disappearing.

7. Division of the main sympathetic trunk produces a greater and more lasting vasodilatation than peri-arterial sympathectomy of the corresponding main artery.

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THE EFFECT OF ABDOMINAL OPERATIONS ON THE MECHANISM OF RESPIRATION:

WITH SPECIAL REFERENCE TO PULMONARY EMBOLISM AND MASSIVE COLLAPSE OF THE LUNGS.

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It seems well established that operations on the abdomen are definitely more liable than surgical procedures in other parts of the body to be followed by two types of complication : (1) Pulmonary embolism and thrombosis ; and (2) Collapse and inflammatory affections of the lung bases.

Pulmonary Embolism and Thrombosis.—With regard to these conditions, a considerable amount of evidence exists to show the etiological importance of abdominal operations. For example, Petren[1] (1913) analysed 439 cases of pulmonary embolism from the literature, 83 per cent of which followed abdominal operations ; while of his own series of 45 fatal post-operative cases, no fewer than 40 were the sequel of abdominal procedures. Lister[2] (1927), in a very carefully controlled study based on the records of the London Hospital for the years 1909 to 1925 inclusive, was able to bring forward definite statistical proof of the predisposing influence of an abdominal operation. Ducuing[3] (1929) showed that in a large collection of clinical examples of thrombosis the percentage incidence after abdominal operations was much greater than that following operations elsewhere. The present writer was able to obtain figures from 31 of the big London hospitals for the year 1926. Out of a total of 54,253 operations, there were 50 cases of fatal pulmonary embolism, of which no fewer than 43 followed abdominal operations. Again, out of 23 cases of post-operative pulmonary embolism met with in the five years 1923–1926 in the Post-mortem Room of the Middlesex Hospital 20 were abdominal operations. Taking as a sample the total number of operations performed in one year (1926) in the above hospital, it was found that extra-abdominal operations (excluding dental, aural, and ophthalmic) were more frequent than abdominal in the proportion of, approximately, 2 to 1 ; so that in this series the predisposing influence of the abdominal incision is again well brought out. In the early part of the present century it was thought that lower abdominal and pelvic operations were especially liable, presumably because operations in these regions were the most frequently performed. But with the spread of surgical enterprise to all parts of the abdominal cavity, it gradually became realized that it was not so much an operation in any special part of the abdomen, but abdominal operations generally, which showed this particular predisposition to thrombosis and embolism. Thus, Lister[2] was able to detect no undue frequency following pelvic operations, while the percentage

in *Table III*, while *Table IV* gives similar readings from a group of control non-abdominal cases. It will be seen that the results are so variable, probably owing to uncontrollable extraneous factors, that it is difficult to come to any definite conclusions. Some cases show a bigger volume of tidal air with an abdominal wound, others a smaller. But if a comparison is made with the control series, one may note that a reduction in the amount of air expired

*Table IV.—*Controls : Non-abdominal Cases.

| No. OF CASE | SEX AND AGE | OPERATION | TIDAL AIR | | + or - |
			Before Operation	After Operation	
1	F., 48	Radium to cervix	335 c.c.	416 c.c.	+
2	F., 40	Examination under anæsthetic	271 c.c.	290 c.c.	+
3	M., 41	Radium into perineum ..	310 c.c.	353 c.c.	+
4	F., 48	Perineorrhaphy	372 c.c.	311 c.c.	—
5	M., 58	Excision of carcinoma of anus	232 c.c.	307 c.c.	+
6	F., 48	Radical carcinoma of breast ..	260 c.c.	428 c.c.	+
7	M., 62	Amputation of breast	406 c.c.	534 c.c.	+

with each normal respiration is more commonly met with following abdominal than other types of operation. It seems a fair conclusion, therefore, that, while an abdominal operation has no very constant effect on the depth of a normal respiration, it shows a somewhat greater tendency than operations elsewhere to be associated with a reduction.

The Movements of the Diaphragm.—To determine the precise manner in which an abdominal operation interferes with respiration it will now be necessary to go into the question in more detail ; and one may conveniently begin with the chief muscle of inspiration, the diaphragm. The movements of this muscle were studied by means of radiographs taken before and after operation. Since it was found impracticable within a few days of operation to transport patients to the skiagraphical department for screen examinations, the following standard technique was adopted. Before operation two X-ray photographs of the chest and diaphragm were taken with a portable apparatus at the patient's bedside, one at the end of expiration, and the other with the breath held in deep inspiration. Two days after operation similar exposures were made, the patient's bandages being temporarily loosened. On both occasions care was taken to have the position of the patient relative to the X-ray tube the same. All photographs were taken by the same radio-grapher, using the same apparatus. The technique being thus standardized, the results may be considered comparable. In all, seven cases submitted to abdominal operations were studied, while four cases of radical excision of the breast were used as controls. The breast operation was chosen as a control because, in spite of its proximity to the respiratory apparatus. it is recognized as being rarely followed by thrombotic or embolic complications.

Results of Investigation of Abdominal Cases.—In all seven abdominal cases the respiratory excursions of the diaphragm were diminished. In one case (an upper abdominal laparotomy) the diminution of diaphragmatic movement was classified as 'slight'. In three cases (a hysterectomy.

cholecystectomy, and a radical cure of an inguinal hernia) the diminution was classified as 'moderate'. In three cases (a cholecystectomy, a laparotomy, and a pylorectomy) it was classified as 'marked'.
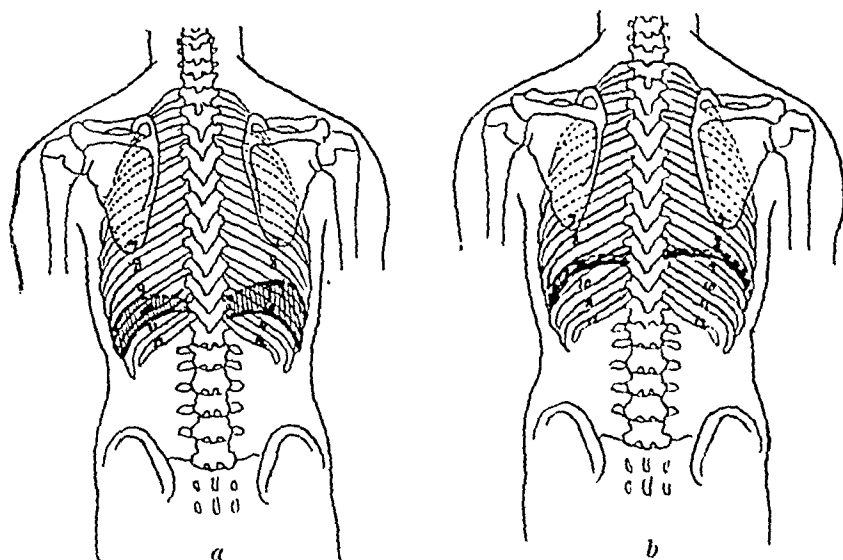
FIG. 294.—'Marked' diminution of diaphragmatic movements after cholecystectomy (as shown in red). *a*, Before operation; *b*, After operation.

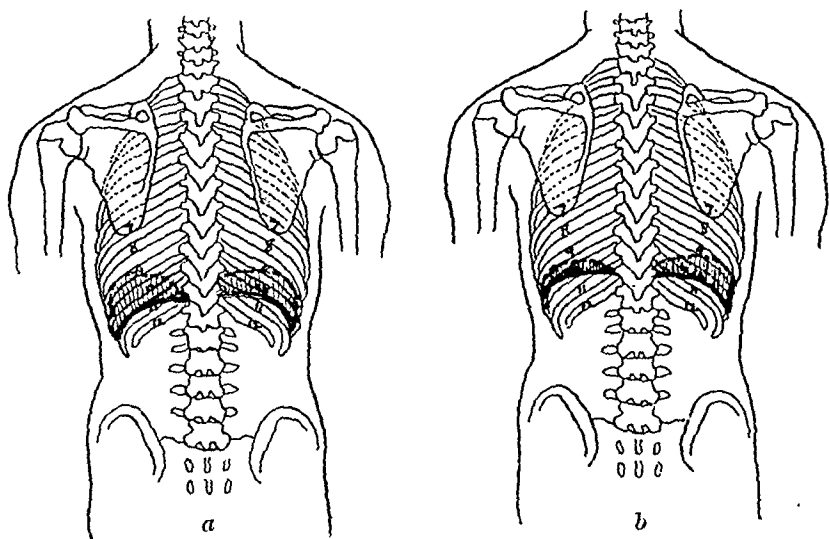FIG. 295.—'Moderate' diminution of diaphragmatic movements after cholecystectomy. *a*, Before operation; *b*, After operation.

Figs. 294 and 295 illustrate typical cases, the former being an example of 'marked', and the latter of 'moderate' diminution. In two cases the diaphragmatic movements, in addition to being diminished, took place about a higher level, owing to pressure from below by distended coils of gut.

Results of Investigation of Control Cases.—Of the four cases of radical operation for carcinoma of the breast, three showed as wide a range of diaphragmatic movement after operation as before, while one case showed a diminution which was less than that classified as ' slight ' in the abdominal cases, and may therefore be termed ' very slight '. In one case the diaphragmatic movements on the operated side were not only as extensive as before operation, but took place at a lower level. This patient complained of pain on the affected side of the chest on deep inspiration, and it is possible that as a result of this there was a diminution of costal respiration, and a compensatory increased descent of the diaphragm on that side.

Suggested Means of Combating the Diaphragmatic Inhibition.—Many efforts have been made by surgeons to overcome this inhibition of the diaphragm after an abdominal operation, but so far without any uniformity of success. Post-operative deep-breathing exercises, which are often recommended and employed, labour under the disadvantage that, while they will certainly induce a sluggish muscle to move efficiently, they have little effect on a diaphragm which is being seriously inhibited by pain impulses from an abdominal wound. Indeed, one sometimes finds that a patient who clinically appears to be performing the exercises most efficiently, is really, when X-ray examinations are made, using the diaphragm very little. The suggested use of inhalations of CO_2 gas as a routine after operation for the same purpose seems open to similar objections. The problem has sometimes been attacked from the other side, and attempts made to diminish the pain in the abdominal wound, which is the cause of the trouble. Novocain and other such local anæsthetics, however, are too transitory in their effects to have any real value in this connection ; while, as to the suggestion that morphia might be useful, the writer found that in the only case in which he studied its action, so far from enabling the diaphragm to descend more efficiently, its use caused this muscle to become more elevated—thus suggesting, if this one case be a criterion, that any beneficial effect that morphia may have on the pain is more than counterbalanced by the general loss of tone resulting from its use. We must therefore conclude that at present the problem of efficient diaphragmatic movement in the presence of an abdominal wound remains unsolved.

Expiration.—While the effect of an abdominal operation on the diaphragm has been the subject of much inquiry and speculation, the corresponding effect on the expiratory muscles has excited comparatively little interest. Presumably this is because their particular study presents greater difficulties. We have already noted that patients with abdominal incisions often complain of pain in the wound at the end of a long expiration owing to the contraction of the abdominal muscles involved in this act, but it is not possible to determine directly the degree of such interference. In this study the effect of an abdominal incision on the muscles of expiration was investigated indirectly by a determination of the alveolar CO_2, the rationale being the following.

If a patient expires deeply, and the last portion of expired air is trapped and analysed, an estimation of the percentage of CO_2 in the alveolar air may be made. If for any reason the patient is unable to expire so deeply, the

sample becomes diluted by the air in the trachea and bronchi, a lower CO_2 reading being obtained. Provided, therefore, that one has a pre-operative standard for a given individual, and that care is taken to exclude patients with acidosis and other gross metabolic disturbances, the degree of dilution of the sample of air taken at the end of expiration may be looked upon as a rough index of the amount of interference with the muscles of expiration.

A series of patients before and after an abdominal operation were investigated in conjunction with Mr. H. F. MacLaglan, who analysed the samples in a Haldane's gas apparatus. The specimens were collected by the syringe technique described by Dodds.[7] The following readings were obtained from a typical case—B. C., male, age 30. Operation : left inguinal hernia.

	Percentage of CO_2 in specimens taken.
Before operation	6·13
	5·8
	6·25
Second day after operation	5·78
	5·08
	4·5
	4·0
Seventh day after operation	5·93
	6·09

The two changes that may be noted in the readings on the second day after operation, as compared with the pre-operative, are that the CO_2 percentage after operation tends to be rather lower, and that after the first few readings its concentration rapidly diminishes. The reasons for these alterations are quite obvious. The abdominal muscles constitute the chief active expiratory agents, and, being interfered with by an incision, they are unable to express the air from the lungs so completely ; with the result that dilution with tidal air takes place, and a lower reading is obtained. The progressive diminution of the post-operative readings may likewise be explained by the greater tendency of the injured musculature to tire.
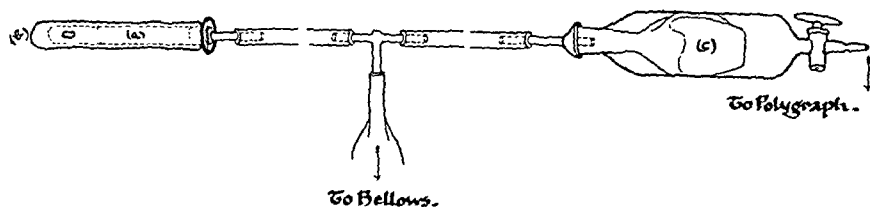
FIG. 296.—Diagram of apparatus used for investigating variations of intra-abdominal pressure. (a) is a glass tube with a lateral hole, surrounded by a rubber finger-stall. (b) By means of a bellows connected with the apparatus by a T-piece, the finger-stall can be distended after intrarectal introduction. (c) is a rubber balloon within a glass chamber, the further end of which is connected with a polygraph recording apparatus.

The Intra-abdominal Respiratory Variations of Pressure.—Finally, the effect of an abdominal incision on the respiratory variations of intra-abdominal pressure was considered. The apparatus shown in *Fig.* 296 was used for the investigation. The glass tube was introduced into the rectum, and the finger

stall distended. A curve of the variations of intra-abdominal pressure was obtained by connecting this to a polygraph recording apparatus.

In a normal individual breathing quietly, one finds a slight rise of intra-abdominal pressure with inspiration, and a fall with expiration. On deep breathing the respiratory undulations are similar but more marked. *Fig. 297*
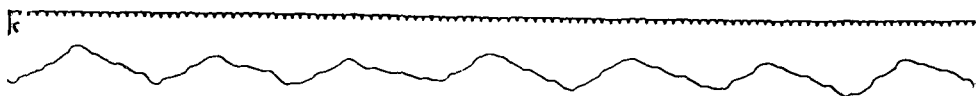
FIG. 297.—Tracing from normal patient showing variations in intra-abdominal pressure corresponding to respiration. The rise was associated with inspiration, the fall with expiration. Note the secondary curves due to the pulse, which in this case are well marked.

shows a typical tracing. In addition to this usual type of curve, one occasionally meets with a second type of curve in normal subjects breathing deeply, a well-marked example of which is illustrated in *Fig.* 298. It will be seen to consist of regularly alternating high curves (*a*), and smaller flatter curves (*b*). The upward stroke of (*a*) corresponded to inspiration, and so

FIG. 298.—Tracing of the intra-abdominal pressure of a normal patient showing a somewhat unusual curve. *a* is the ordinary rise and fall with inspiration and expiration, while *b* is a late expiratory rise due to a forcible contraction of the abdominal muscles after the diaphragm has ceased acting.

far the record resembles the previous one. The secondary (*b*) occurred during the latter part of expiration, and must be due to abdominal muscles of expiration continuing to act after the diaphragm had returned to its normal position, thus causing a further rise of pressure. That the secondary curve is a voluntary act, caused by the forcible expiratory straining, and not a part of ordinary reflex respiration, is shown by the fact that it disappears under anæsthesia (*Fig.* 299). Apart from these two types of normal curve, the only other
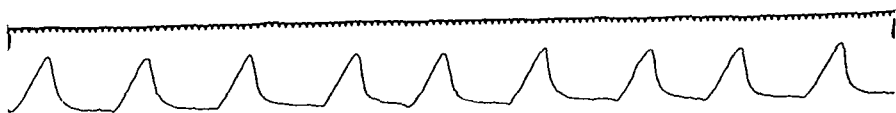
FIG. 299.—Curve of intra-abdominal pressure from same patient as in *Fig.* 298 while under the influence of a general anæsthetic. Shows automatic respiration, with no trace of curve *b*.

point of interest noted in the control subjects was that, in one patient with bronchitis and bronchial spasm, owing to his difficulty with expiration, the curve was reversed, a slight rise occurring with expiration rather than inspiration.

Having obtained a series of normal curves, a number of patients were studied before and after an abdominal operation, to determine the effect

produced by an abdominal incision. Occasionally no marked differences were noted, but as a rule quite definite changes in the curves were seen after operation, which may be summarized as follows : (1) The post-operative curve is less regular ; (2) The undulations of quiet respiration are diminished, and the amplification on deep breathing is much lessened as compared with before operation ; (3) The secondary curve of late expiration, if present before operation, is either greatly diminished or disappears.
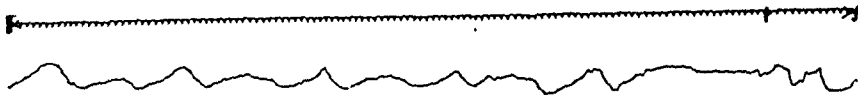
Fig. 300.—Tracing of intra-abdominal pressure of the same patient as in *Figs*. 301, 302. Shows the irregular character of the respiratory variations in intra-abdominal pressure after abdominal operation.

Fig. 300 affords a particularly well-marked example of the results of an abdominal operation. A series of control experiments was performed on patients who had been submitted to the operation of radical excision of the breast for carcinoma, but no gross effect was produced thereby.

The Importance of the Respiratory Variations of Intra-abdominal Pressure.— The normal variations of intra-abdominal pressure with respiration must be an important mechanism in aiding the return of blood from the inferior vena

Fig. 301.—Showing artificial rises of intra-abdominal pressure produced by abdominal massage.

caval system of veins to the heart ; for the intra-abdominal pressure rises when the intrathoracic pressure is lowered, its positive pressure thus aiding the aspiratory effect of the negative intrathoracic pressure. If, as we have seen, an abdominal incision disorganizes this abdominal pump mechanism, a tendency to stasis in the great veins of the abdomen must result, a condition of affairs which it is always assumed predisposes to thrombus formation. In considering measures to counteract post-operative venous stasis, one may note

Fig. 302.— Showing action of abdominal massage in reinforcing the action of the abdominal pump mechanism if applied during deep inspiration only.

that it is quite easy by massaging the abdomen to produce a rise of intra-abdominal pressure. *Fig.* 301, which is from a patient seven days after the operation of appendicectomy, shows this, each undulation corresponding to a pressure of the hand on the abdomen. In order, however, that such abdominal massage shall reproduce the action of the normal abdominal pump mechanism and play its full part in aiding the venous return, the pressure

should not be applied irregularly, but during inspiration when the intra-thoracic pressure is lowered. *Fig.* 302 shows how, when applied in this manner, the respiratory undulations are reinforced. One may conclude from this that properly applied abdominal massage should be a measure of some value in combating post-operative venous stasis, and might be used to supplement the procedures ordinarily used for this purpose.

Discussion.—We have seen that in practically all abdominal cases investigated there must have been a certain deficiency of expansion of the lung bases, and a certain amount of venous stasis after as compared with before operation. In no instance did collapse of the lung or embolic complications occur, and the conclusion must be reached that any effect that respiratory sub-efficiency has in this connection is of a subsidiary or predisposing nature only, and that other factors of an exciting nature are necessary for the development of the complications. As stated early in the paper, this investigation started from the assumption that the reason for the special frequency of the above complications after abdominal operations was a mechanical one. This assumption may be incorrect, and it may be that the special liability of abdominal operations to be followed by pulmonary collapse and embolism depends, not on a mechanical factor, but on something of another nature. It is not proposed, however, to enter into this aspect of the subject here. A question more closely related to the present investigation is whether measures directed to restoring the efficiency of respiration reduce the incidence of these complications. A certain amount of evidence exists to suggest that such measures are of value, but much of the literature on the subject is unsatisfactory and inconclusive. It does seem reasonable, however, since abdominal operations are known to interfere with the efficiency of respiration, to endeavour to combat such interference. In the present state of our knowledge, measures directed to this end cannot be regarded as having a guaranteed prophylactic value, but such an investigation, if rigidly controlled, would constitute a useful piece of clinical research. As a result of this study, one would specially emphasize the importance of combating post-operative distension of the abdomen, owing to its effect on the diaphragm ; the value of a firm support in 'splinting' the injured abdominal musculature ; and the theoretical considerations in favour of the employment of abdominal massage after operation.

SUMMARY.

1. It is shown by references to the literature, and by personally collected figures, that thrombosis and embolism, and massive collapse and inflammatory affections of the lung bases, are more liable to be met with after abdominal operations than after surgical procedures in other parts of the body.

2. Acting on the theory that this special liability depends in some way on an interference with respiratory function, a study has been made of the effect of an abdominal operation on the mechanism of respiration.

3. The effect of an abdominal operation on the vital capacity, tidal air, movements of diaphragm, and the respiratory variations of intra-abdominal pressure, is shown.

4. The value of several suggested remedial measures is discussed.

5. It is concluded that any influence that interference with respiration has is of a predisposing nature only, and that other factors are also necessary for the development of the above complications.

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THE RADIUM PROBLEM.

II. RADIUM TREATMENT OF BUCCAL CARCINOMA.

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In the treatment of malignant disease in any site we are concerned with the primary growth, the immediate lymphatic drainage area, and more distant metastases, generally in the thorax or abdomen, either blood- or lymph-borne. Radium therapy at its present stage cannot pretend to deal with the last type, and although the treatment of the primary growth in buccal carcinoma is on a satisfactory basis, considering the limitations of the method, the problem in the lymphatic drainage area is by no means solved.

Theoretically, metastasis to the lymph-glands in buccal carcinoma may occur by embolism, by permeation, or by both, but at an early stage clinical evidence points to embolism as the method of dissemination. In a large number of recorded cases treated by various methods cures have resulted from the extirpation of the primary growth and secondary deposits as separate entities, no attention having been paid to the intervening lymphatics. If spread had occurred by permeation we should have to assume that the lymphatics had dealt with the contained malignant cells, and I am aware of no histological evidence in support of the theory of permeation. Squamous-celled carcinoma, indeed, in all situations appears to spread by embolism. In such sites as the hand or foot the secondary deposits are in the lymphatic glands, and no nodes develop along the paths of the lymphatics, which one would expect if permeation were the mode of spread.

There is, therefore, justification for dealing with the primary growth and the gland-bearing area as separate entities. The lymphatic glands are the natural means of defence against the spread of the disease in that they act as filters, and it is quite possible that they may be able to deal with malignant emboli just as they do with bacteria. It is therefore reasonable to attempt treatment of the primary growth first of all, and so remove a source both of sepsis and malignant embolism. If, for example, a unilateral block dissection—which by many is considered the best method of dealing with the lymphatic drainage area—is performed prior to the treatment of the primary growth, the lymphatic flow is diverted to the opposite side, and the glands there, which may previously not have been involved, may become so. The performance of a block dissection also interferes with the blood- and lymph-supply of the affected side, and this increases the tendency to radium necrosis. On all grounds, therefore, we feel that the primary growth should first be treated.

Diagnosis.—In Manchester it is almost invariably our practice to rely on the clinical evidence in making a diagnosis of buccal carcinoma. Of necessity, particularly before radium became recognized as a valuable therapeutic agent, a large number of the cases which were referred for treatment were recurrences after surgical operations. From a study of these I have been particularly impressed by the injurious effects of incomplete operations in malignant disease, and regard biopsy as such a procedure. The number of cases treated since the present technique was instituted is about 500, and there is ample evidence from a study of the material from the secondary deposits obtained from block dissections to prove the fact that in a large number of cases radium can cure primary growths in the mouth. · If a few cases are wrongly diagnosed, they can scarcely, with such a large number, affect the statistical position, and I feel that biopsy is a bad procedure in the interest of the patient. Mr. Geoffrey Keynes tells me that he has discontinued the procedure in treating breast carcinoma, for the reason that recurrence took place in the scar by implantation. Radium treatment is a conservative procedure in the mouth, and the position is quite different from that of the surgeon who proposes to perform a complete or partial glossectomy and who must be sure of his diagnosis.

Histology.— Although biopsy has not been practised, the material obtained from block dissections, which often form an integral part in the complete treatment of a case, has always been examined. In general the histological character of the primary growth is reproduced in the secondary deposits, and after a time it was evident that the microscopical characters
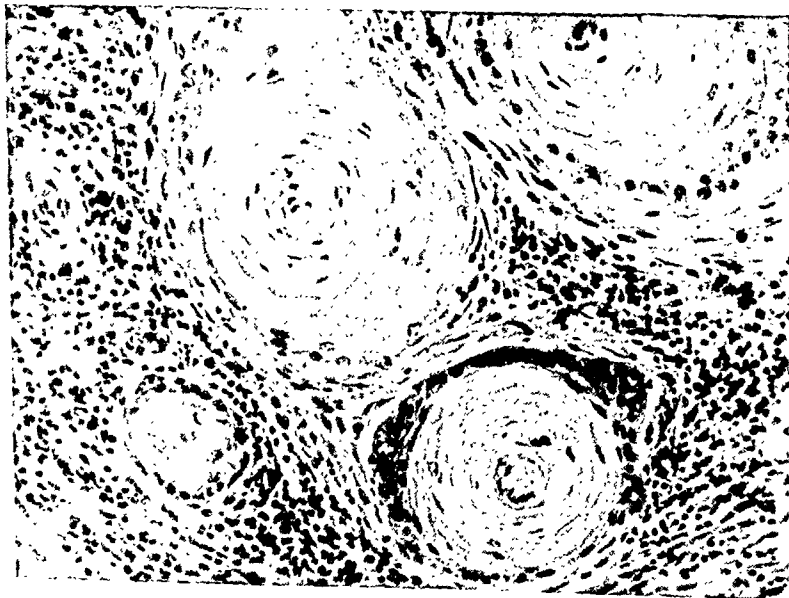
FIG. 303.—Squamous epithelioma of floor of mouth. This is an extreme case of differentiation. Correspondingly metastasis is often late, and in this particular case there was no clinical evidence of metastasis until three years after the primary lesion had been cured.
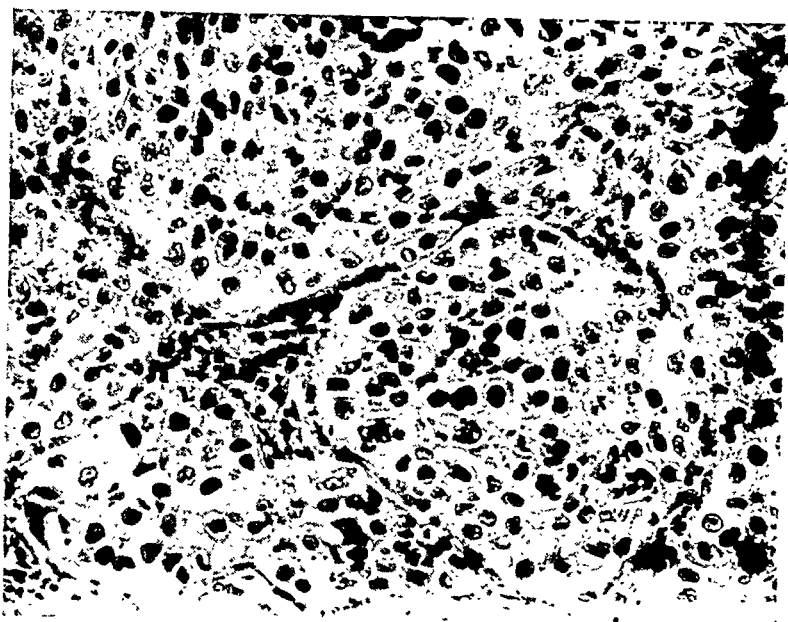
FIG. 304.—Undifferentiated squamous epithelioma. Base of tongue.
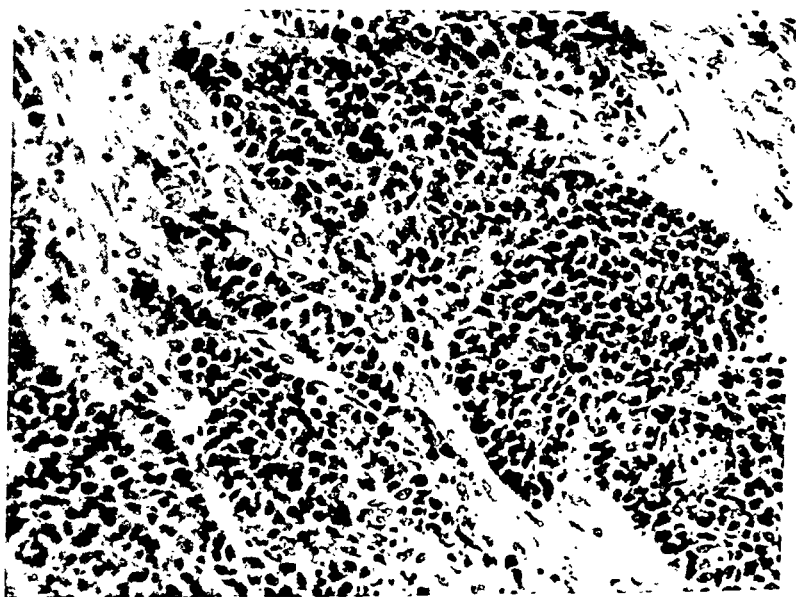
FIG. 305.—An undifferentiated squamous epithelioma of the middle third of the tongue. This resembles the type invariably met with at the base.

exhibited considerable variations. An attempt has been made to correlate these variations with the different sites in the mouth, and the observations from a large number of cases are as follows:—

1. *Buccal Surface of Cheek, Lips, Floor of Mouth, Infralingual Surface of Tongue, Anterior Third of Dorsum of Tongue, Alveoli.*—A highly differentiated type is observed in which cell-nests and keratinization are marked features. Corresponding with this, growth is not so rapid and metastasis is not so early.

2. *Base of Tongue.*—Almost invariably a highly cellular, undifferentiated, squamous epithelioma is observed, which resembles that found in the pharynx and cervix uteri. Cell-nests are rarely, if ever, found. Metastasis is early, and often occurs in the mediastinum, lungs, and even the liver. This type is extremely radio-sensitive.

3. *Middle Third of Tongue, Fauces and Tonsils, Uvula and Soft Palate.*—On the whole an intermediate type is found, in which keratinization is not so marked as in the first class. On the other hand, occasional highly keratinized and also highly cellular types are met with.

Microphotographs (*Figs. 303–305*) are reproduced to show extreme variations. All types respond to radium, but the most brilliant local results are often obtained in advanced cases at the base of the tongue; such results are not procured in the anterior and more accessible parts of the mouth with equally advanced cases.

In an early series of 78 cases the sites of origin in the tongue were investigated: 52 (66 per cent) were in the middle third; 16 (20 per cent) were in the anterior third; 10 (12 per cent) were in the base.

The Evolution of Radium Treatment in the Primary Site.—This is an interesting subject, and, just as in nature development proceeded along different lines, by a process of elimination some uniformity of method has resulted. Naturally at first treatment was a process of trial and error, but Dominici first realized the importance of filtration, and the principle of the selective action of the γ ray.

Surface application was first tried with comparatively intense sources for short periods of time. If these are not filtered, β rays are given full play, but their effect is very localized and differs little from that of the cautery. The law of the inverse square, by which the intensity of the rays, whether β or γ, varies inversely with the square of the distance, also made this an unsuitable method except for very superficial types of growth. It is true that it is theoretically possible to increase the intensity at the surface so as to discount this effect at a depth, but the immediate effect around the source then becomes so intense as to produce necrosis or a burn.

Implantation of needles containing radium salts or emanation followed, and was first tried by Stevenson and Joly, of Dublin. Fairly intensive sources were used, but the principle of filtration so as to use only γ rays was not employed. Twelve to twenty-four hours were average exposures.

The war period undoubtedly retarded advances, but gradually the intensity of the implanted sources was cut down, and the time of exposure correspondingly increased. This was the foundation of the modern method of treatment for the primary growth in buccal carcinoma, and is largely due

to the work of Regaud, who combined this principle with the filtration advo-
cated by Dominici. The American School at this period discarded filtration
entirely, and implanted small capillary tubes of glass containing emanation,
which were left in the growth. Some of these sloughed out, but some remained
permanently in the tissues. Owing to the action of the β rays an intense
reaction with necrosis and sloughing resulted, and, although many good
results were obtained, many patients died from the sepsis, pain, and conse-
quent exhaustion which often occurred. This method, sometimes combined
with electro-coagulation, was used at the Manchester and District Radium
Institute before the present technique, which was adopted at the end of 1925.
An analysis of some 50 cases which were apparently cured for varying periods
of from one to nine years showed that this principle of prolonged irradiation
was responsible for 80 per cent of these apparent cures. The contrast between
the severe reaction of the unscreened method of treatment and the uniformity
of result and comparative painlessness of Regaud's method was to me dramatic.
The result has been that rarely is a case treated without marked amelioration
of symptoms even if a primary cure is not obtained, and this is reflected in
the fact that a patient who has been treated seldom fails to attend again for
examination when requested to do so.

TECHNIQUE.

Needles or Seeds ?—There is at the present time in this country a differ-
ence of opinion as to the advantages in the use respectively of needles and
removable platinum radon seeds. In both, the external diameter is cut down
to a minimum and the trauma from insertion is on this account negligible,
but seeds have a relatively short active length—0·3 mm. is commonly used—
whilst needles may vary between 10 and 30 mm. in length. The method of
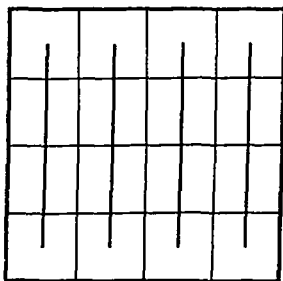
FIG. 306.
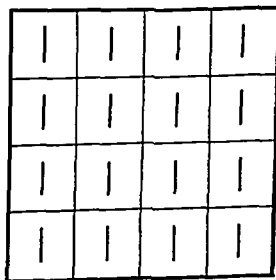
FIG. 307.

implantation, however, depends a great deal upon the skill of the operator,
and, when a physical agent is being used which is constant in its action, we
feel strongly that any method which tends to eliminate this variable human
factor should, as far as possible, be adopted.

If *Figs*. 306, 307 represent a cross-section of an area to be implanted,
then it is obviously easier to insert four needles each of active length 12 mm.
than 16 seeds of active length 3 mm. As a practical illustration, we have
personally used with success 20 needles each of active length 15 mm. in the

treatment of a buccal carcinoma, representing a total active length of 300 mm. We doubt whether the equivalent active length in seeds, which would require 100, could have been adequately spaced. Failure to implant accurately means that some part of the tumour is under-irradiated, leading inevitably to recurrence.

Filtration.— Personally we use a minimum filtration of 0·5 mm. of platinum, which allows about 0·4 per cent of β irradiation to pass into the tissues, and a maximum of 0·6 mm. of platinum. Practically all our radium element is put into cells of wall thickness 0·2 mm. of platinum, and these cells are contained in sheath needles of wall thickness 0·4 mm., giving a total filtration of 0·6 mm. The weak point in a needle is the seal between the trocar point and the body, and we consider that the use of cells gives twice as much protection against leakage due to trauma or the accidental contact of mercurial or iodine solutions with the gold seal.

Dosage.—It is often stated that a 'dose' of so many milligramme-hours is suitable for a case of buccal carcinoma; but this is a useless expression. If needles are implanted a certain distance apart, then obviously their number and the total amount of radium element or emanation used will vary with the size of the growth. Empirically we know that linear sources containing so much radium element or emanation can be inserted into normal tissues for corresponding time periods without harm, and the optimum relations of time and intensity are also known. The important points then in detailing technique are : (1) The linear intensity or the quantity of radium element or emanation contained per linear centimetre—the diameter of the source is reduced to a minimum and is a constant ; (2) The screen or filter ; (3) The time of exposure ; (4) The number of sources used, and their active length ; (5) The position of the sources, and their distance apart.

Active Length. — The active length of an implanted source refers to that part of the needle which contains radium salt or its emanation. In buccal carcinoma the most useful active length is 15 mm., but as a variable quantity it can be expressed as being between 10 mm. and 30 mm.

Our technique according to the above considerations is as follows :—

1.	Linear intensity	.. .. ..	0·66 mgrm. radium element / 1·7 to 2 mc. of emanation
2.	Screen	.. ..	0·5 to 0·6 mm. of platinum
3.	Time of exposure	.. ..	7 to 12 days
4.	Active length ..	.. ..	10 mm. to 30 mm., but the commonest is 15 mm.
5.	Number of sources / Distance apart ..	.. .. /	Rarely exceeds twenty / 1 to 2 cm.

Anæsthetic.—A general anæsthetic is given whenever possible, and our preference is for the intratracheal method. Palpation of the growth is essential, and the treatment of growths at the base of the tongue is considerably helped by forcible traction and bimanual palpation. We do not believe that this can be adequately performed under local anæsthesia. Almost invariably we find during the examination under general anæsthesia that the growth—if the tongue is involved, at any rate—is more extensive than the ordinary clinical examination reveals, owing to the intolerance of the patient. This should be remembered in estimating the number of needles.

Removal of Teeth.—Most authors stress the importance of removal of septic teeth before radium treatment is given. We cannot agree entirely, and think that it is a definitely bad procedure where the growth lies near or is in contact with the alveolar margin, as frequently happens in lesions which involve the floor of the mouth. Quite often a patient gives a history of a " sore place in the floor of the mouth " followed by a visit to a dentist with extraction of teeth. After this the condition, he says, became definitely worse, and we believe that rapid spread often occurs along the alveolar margin as a result. In cases where a sharp and carious tooth has been the main factor in the production of a carcinoma of the middle third of the tongue the extraction of this is beneficial, but personally I prefer to proceed with treatment rather than that delay should be caused by a widespread removal of teeth.

Fixation of Needles.—It is extremely important that needles be securely sutured, as otherwise—except where the base of the tongue is concerned—they will scarcely be retained for the full time period. There are various ways of doing this, and we have found the following method satisfactory.

(A) ANTERIOR THIRD OF DORSUM OF TONGUE.   (B) BASE OF TONGUE.

(C) SOFT PALATE.   (D) FAUCES AND TONGUE.   (E) MIDDLE THIRD OF TONGUE.
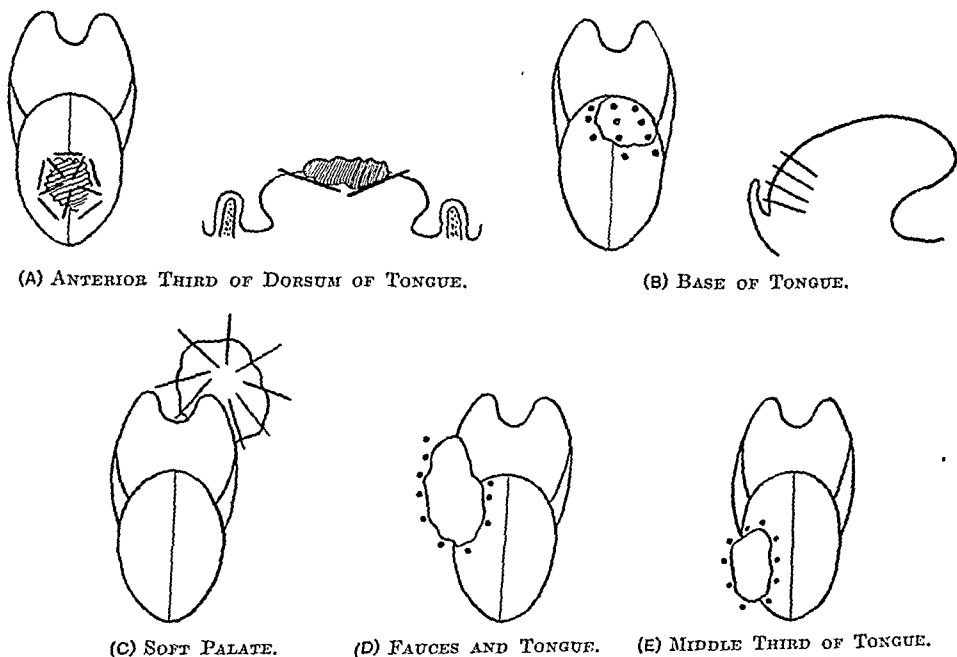
FIG. 308.—These diagrams indicate roughly a suggested arrangement of needles in various sites. As far as possible they are buried in healthy tissue parallel with the infiltrating edge of the lesion. An exception is the base of the tongue (B), where they are systematically implanted at right angles to the surface both in the tumour and in healthy tissue.

In the first place, stout silk thread is threaded through the eyelets of the needles before they are sent up to the theatre. The distal end is knotted, leaving a double length of about eight inches. A knot is then tied close to the eyelet hole, and through this is passed a piece of iodized catgut threaded in a Lane's half-circle palate needle. When the needle has been implanted

it is securely anchored by the catgut suture to healthy tissue if that is possible. As a rule, by the end of seven or eight days the catgut will have become partially absorbed and simple traction suffices to remove the needles. After all the needles have been secured individually the silk threads are gathered together and sutured, about one and a half inches from their attachment to the needles, to some part of the buccal mucosa. The ends are then brought out at the angle of the mouth, and fixed to the cheek with adhesive plaster. Any accidental traction on the silk threads will therefore not be transmitted to the needles.

Wherever it is possible needles are implanted outside and parallel with the infiltrating edge of the lesion, but with a large nodular growth, such as may be found in the tongue, they are also inserted into the lesion itself. They should not be placed close to bone if this can be avoided, as a troublesome necrosis may result ; but if bone is invaded, then it is almost impossible to avoid this if a cure is to be obtained.

A few diagrams which illustrate the insertion of needles in various sites are shown in *Fig.* 308, A–E, but it is impossible to lay down any hard and fast rules. Experience and a careful examination of all patients after treatment are the main factors in success.

Element or Emanation ?—Personally we have not come to any definite decision with regard to the use of element or emanation. The former gives a constant intensity of irradiation, the latter one which diminishes by one-sixth per day. If a time period of eight days be taken, then, with a linear intensity of 0·66 mgrm. of radium element, the number of milligramme-hours per unit of length is $8 \times 24 \times 0.66$, or 127. If the initial linear intensity is 1·8 mc., then that at the end of eight days will be 0·45 mc., and the millicuries destroyed 1·35, a quantity equivalent to 179 milligramme-hours. An initial intensity of 1·3 mc. per linear centimetre is physically equivalent to 0·66 mgrm. of radium element for a period of eight days. In practice, however, we have found 1·8 mc. to be a suitable strength, and there is the possibility that if the intensity should fall below a certain level no effect will be produced on the malignant cells. Russ[1] refers to the experimental proof of this.

We have a distinct impression at the moment that those cases of buccal carcinoma which have developed necrosis have occurred where radium element has been used, but the whole question will have to be analysed more carefully before any definite conclusion can be reached.

Notes on Technique in Various Sites.—

TONGUE.—

Anterior Third of Dorsum.—It is extremely rare in our experience for an epithelioma to arise here except on a chronic specific glossitis. In such cases the nutrition of the tissues is not normal owing to an endarteritis and lymphangitis obliterans and the scars of healed gummata. The result is that the normal response is interfered with, and in some cases such epitheliomata appear to be definitely radio-resistant. In other cases the lesion may disappear, but an indolent ulcer with sharply cut edges and a depressed base may persist, which takes a considerable time to heal. On the whole we are in favour of a prolongation of the time period to about ten days in these cases, with a screen of 0·6 mm. of platinum. Needles of active length 15 mm.

are suitable. Lymphatic spread is usually late here, probably owing to the tendency to obliteration of the lymphatics by the chronic inflammation of specific origin. (*See Figs.* 303 A.)

Middle Third.—These lesions usually start at the border of the tongue just anterior to the faucial pillar, and tend to spread into the substance of the tongue, on to the floor of the mouth, and on to the fauces and tonsil. We generally use needles of active length 15 mm. In the tongue they are inserted at right angles to the surface around the medial border of the lesion, whilst they are pushed horizontally backwards below the growth. If invasion of the fauces has occurred, they are placed horizontally and parallel with one another beneath the base of the ulcer. Sometimes such a growth becomes attached to the ascending ramus of the mandible, and it is then that necrosis of bone is almost inevitable. (*See Figs.* 308 D, E.)

Base.—It is almost impossible to suture any but the most anterior of the implanted foci here, and the growths are often so bulky that the needles have to be placed in the substance of the tumour. Luckily these growths are all of an undifferentiated and radio-sensitive type, and accurate implantation, though desirable, is not so necessary to obtain a good local result as in the more anterior part of the tongue. We always try to place equidistantly from 9 to 12 needles of active length 15 mm. in the base of the tongue irrespective of the apparent extent of the lesion. The tongue is drawn well forward, and, with a right-angled introducer, the needles are inserted at right angles to the surface (*see Fig.* 308 B). They have thus a slightly forward inclination, and accidental traction on the silk threads does not tend to displace them, as its direction is at right angles to the axis of insertion. Retention is aided by the relative immobility of this part of the tongue. A time period of 7 to 8 days is usually sufficient.

SOFT PALATE AND UVULA.—We prefer needles to seeds despite the difficulty of burying them, owing to the thinness of the tissues. With care and persistence and good anæsthesia the operation can usually be performed. In addition to the usual type of active length 15 mm., needles of 10 mm. active length will be found useful. (*See Figs.* 308 C.)

FLOOR OF MOUTH.—As a rule these lesions are superficial and needles can be inserted beneath their base parallel with the floor of the mouth. Needles of active length 10 and 15 mm. are usually employed.

CHEEK.—Implantation is, in our opinion, preferable to surface application, and can sometimes be performed through the external surface of the cheek, in which case the needles are more easily retained. An active length 15 mm. is suitable.

HARD PALATE AND ALVEOLI.—It is difficult to implant needles here, and some form of surface application is desirable. If these growths are seen at an early stage they are often superficial and tend to spread along the paths of least resistance, i.e., along the mucosa. A reference to *Fig.* 309 will give some idea of the form of the apparatus. Upper or lower plates are made of vulcanite, and the units of irradiation are contained in a box. Needles or tubes of suitable active length and standard linear intensity (0·66 mgrm.) are placed in the base and fixed about 1 cm. apart between two layers of adhesive plaster, which can be kept in position by packing

the interior of the box with cotton-wool. As the lesions lie close to bone the screen can with advantage be increased to 0·8 mm. of platinum, so as to cut out the γ rays of longer wave-length. The 'box' keeps the units of irradiation at a distance from the opposing alveolar margin, and is the best method of protection, remembering the effect of the inverse-square law

FIG. 309.—Diagrams to illustrate vulcanite plates which contain radium tubes for the treatment of growths involving the hard palate or lower alveolar margin. 0·8 mm. of platinum is used as a screen so as to absorb the γ rays of longer wave-length owing to the proximity of bone. In each case the units of irradiation are placed in a box between layers of adhesive plaster, the rest of the cavity being packed with cotton-wool. In the case of the palate this keeps the tongue and, in the lower alveolar margin, the upper alveolus, at a distance from the source of irradiation, and lessens the reaction and tendency to necrosis respectively. The intensity of irradiation varies inversely as the square of the distance.
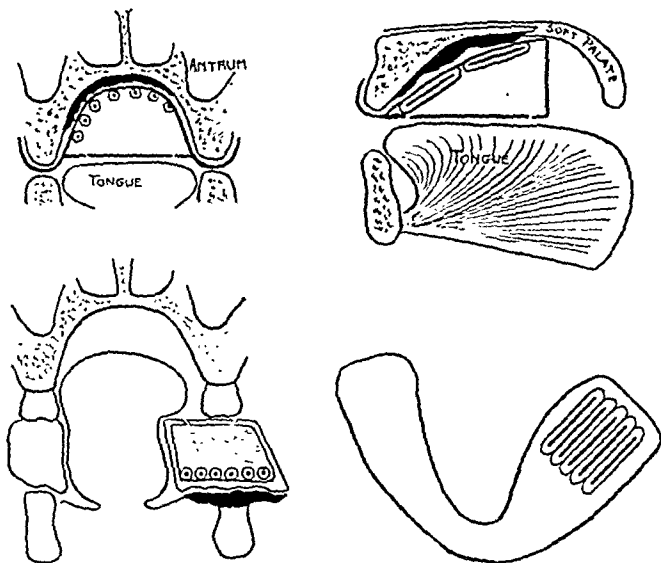
on the intensity of irradiation. Seven to eight days of irradiation will probably prove ample, and it is a good plan to change the position of the tubes, if this is possible, once or twice during the period. Probably more homogeneous irradiation is thus obtained.

Re-insertion.— In all the above situations in which the lesion is very extensive it is better to remove the needles at the end of five days, and re-insert under a general anæsthetic for a similar period of time. Errors of distribution at the first attempt are probably corrected to some extent, and we have found that extensive lesions can be more successfully treated. We regard this as a definite improvement in technique.

Protection of Bony Structures or Adjacent Soft Tissues.—It will probably have been noticed that no reference has been made to the wearing of lead plates over the alveoli or hard palate, as advocated by some authors. We have not found it necessary, and think that it puts too great a strain on the tolerance of patients, which must often have reached its limit. After all, 0·6 mm. of platinum absorbs all the β irradiation, whilst a mould composed of 1 mm. of lead will only absorb about 4 per cent of the total γ irradiation which strikes it.

AFTER-RESULTS OF TREATMENT OF PRIMARY GROWTHS.

Normal Reaction.—In few places can the reaction on a mucous surface be studied so well as in the mouth. By about the tenth day quite an appreciable change will be apparent. If the lesion should be a projecting one it

will have become considerably flattened, and for a variable distance around the lesion of from 1 to 2 cm. the normal mucosa will be covered by an adherent, greenish-yellow, fibrinous deposit, which is perhaps best compared with that on the pleura of the lung of a patient dead of lobar pneumonia. In the case of a nodular lesion the treated area does not look unlike an infarct, and it is curious that the line of demarcation between the reaction zone and the surrounding mucous membrane is very sharply defined. This becomes more

FIG. 310.—An infralingual carcinoma of the tip of the tongue. The second drawing illustrates a perfect reaction, in which the treated area is covered by a greenish-yellow fibrinous deposit. The edge is extremely sharply defined and the lesion now is not unlike an infarct (fourteen days after removal of needles). Six weeks later it is difficult to find any trace of the original lesion, as shown in the lower figure. Treatment: Implantation— 5 needles. Active length, 15 mm. Linear intensity, 2 mc. Screen, 0·5 mm. of platinum. Time, 10 days.

marked as time progresses, and especially if slight over-treatment has been given. At the same time any induration becomes less distinct and in three to four weeks has disappeared, although the treated zone has still a different consistence and feels firmer than the healthy tissues. With a perfect response, in six to eight weeks' time little or no trace will be found of the original lesion. Mobility will at the same time have returned to normal. (*Fig. 310.*)

Abnormal Reaction. — Under-treatment is characterized by the fairly obvious feature of persistent induration, although ulceration may have disappeared.
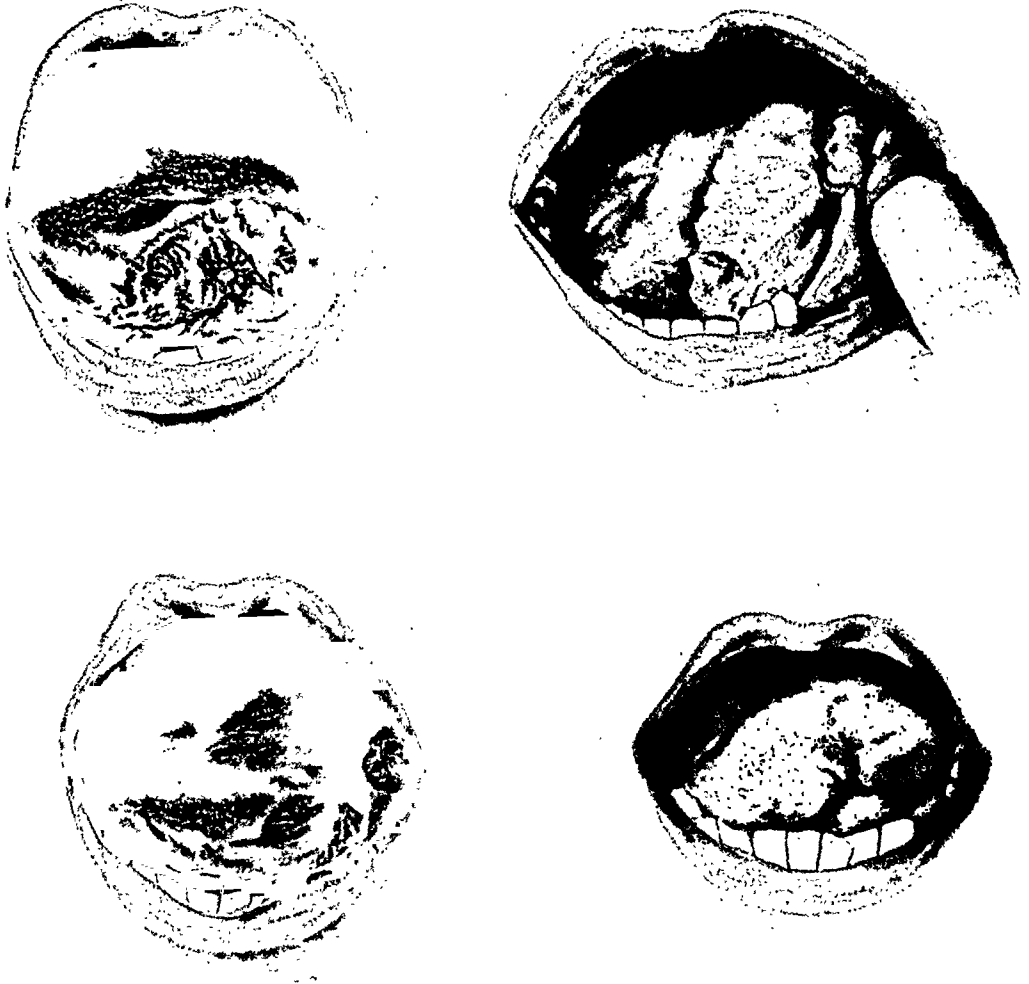
FIG. 311.—These drawings are from a case in which the reaction was slightly excessive. The second drawing was made nine days after the removal of the needles, and should be compared with the corresponding stage in *Fig.* 310. In the third a depressed ulcer is seen at the junction of the tongue and the floor of the mouth, eighteen days later. This took six weeks to heal, leaving a somewhat depressed and puckered scar. Treatment: Implantation—9 needles. Active length, 15 mm. Linear intensity, 2 mc. Screen, 0·5 mm. of platinum. Time, 9 days.

Over-treatment, leading perhaps to radium necrosis, often presents a difficult problem, and it is very probable that, before experience has been acquired, lesions so treated have received a second application under the impression that the growth has not been completely destroyed. This, of

course, only accentuates the condition, and from pain, sloughing, and consequent exhaustion from inability to sleep or take food the patient may succumb. Mild degrees of over-treatment are usually marked by the persistence of the fibrinous deposit to which reference has previously been made. Gross degrees show central ulceration of varying depths, and the edge of the ulcer is usually very sharply defined as though cut with a knife. The surrounding tissues are often œdematous and display a 'woody' type of induration. When the process has reached its maximum the base of the ulcer is covered by a very tough and adherent green slough. These ulcers are extremely painful and tender, and may take eight to twelve months to heal. A depressed scar results which causes puckering of the surrounding tissues and, if the tongue is the site of the lesion, may cause some limitation of mobility (*Fig.* 311). In some cases the ulceration has been so deep that a cul-de-sac lined by epithelium 5 to 10 mm. in depth, and perhaps 0·4 mm. in diameter, results. Necrosis of bone is sometimes met with when a lesion lies near to it, and this is particularly noticeable in the case of growths near the ascending ramus of the mandible and the alveoli. On the whole it is not very frequent, though some authors have advocated resection of the ascending ramus prior to irradiation of lesions involving the fauces. Naturally, when growth is definitely infiltrating bone, necrosis is inevitable. Certain workers advise protection of the lower alveolar margin and of the palate when tumours of the floor of the mouth and tongue respectively are being treated. In Manchester we have not found this to be necessary, nor does it appear reasonable to expect a mould composed of 1 mm. of lead, which only absorbs a minute percentage of γ rays, to protect these structures efficiently. The secondary β irradiation is absorbed by the tissues in which the needles are buried. As stated above, wearing of such apparatus is putting a good deal of additional strain on the tolerance of a patient, which must often have reached its limits already.

Bronchopneumonia. — The only noteworthy immediate complication of treatment is a bronchopneumonia, which we have found in two or three patients treated out of a total of 400. This is a relatively small number taking into account the oral sepsis and enfeebled condition of so many of the patients of the hospital class.

Hæmorrhage.—Severe hæmorrhage was noted in one of our own series whilst the needles were *in situ*. It was probably the result of ulceration through the wall of the lingual artery, and was easily controlled.

Late Necrosis.—Occasionally where a thick scar results—i.e., in those cases which have already been overtreated—ulceration may occur in the centre a year or more afterwards. It is probably due to a progressive endarteritis obliterans, and the breaking down is caused by some temporary superimposed effect, e.g., trauma or friction. Its occurrence in the centre of a lesion a considerable time after treatment, its comparatively rapid onset, the fact that it does not bleed, and that it is immediately lined by a tough, adherent slough, should lead to its detection. Naturally the possibility of recurrence should be borne in mind and the patient kept under close observation, but local recurrence a year or more afterwards is extremely uncommon if a high standard is observed in the assessment of a primary cure.

We have recently seen a case of necrosis of the mandible three years after the primary growth was treated and cured. Two applications were given to the primary growth, an ulcer persisting after the first treatment, which through our inexperience was not recognized as being due to over-treatment. The original lesion was in the middle third of the tongue anterior to the fauces.

TREATMENT OF THE LYMPHATIC AREA.

When the primary lesion has been adequately dealt with, the treatment of the gland-bearing area has to be considered. When all the possibilities of spread are visualized, it will be realized that, no matter whether the original focus involves one or both sides of the mid-line, the area to be covered is a very extensive one. On theoretical grounds external irradiation at a distance would be ideal, but facilities are rarely available for it. The compromise of multiple foci near the skin has not yet shown that it is efficient, at any rate when palpable nodes exist. Finally, implantation would involve such an accurately spaced insertion of a very large number of needles that it would in itself be an almost impossible procedure, and with the surgical exposure necessary a block dissection might as well be performed.

There are three main types of case : (1) Those in which there are no palpable glands ; (2) Those in which there are palpable glands, either unilateral or bilateral, and sufficiently mobile for a radical surgical removal ; (3) Those in which there is unilateral or bilateral glandular involvement too fixed for surgical removal. Opinion varies a good deal as to the procedure in these cases, and the time has scarcely arrived when dogmatism is possible.

1. *Cases in which there are No Palpable Glands.*—It should be remembered that in certain cases metastasis never occurs, or, if it has done so, the lymphatic glands have dealt adequately with the malignant emboli. Surgical opinion would on the whole favour a block dissection if the lesion were unilateral, but opinion would by no means greatly lean towards a bilateral block dissection, owing to the severity of the procedure even when carried out in two stages. Probably the most conservative method is to irradiate both sides of the neck by multiple foci placed at a distance of about 2 cm. from the skin, as advocated by Cade in this country. The technique will be described later. Afterwards the patient is examined at monthly intervals, and a block dissection carried out should palpable nodes appear later.

2. *Cases with Palpable but Mobile Glands.*—Where palpable glands are present a block dissection should be carried out on the affected side. If both sides are involved a double block dissection should be done, with an interval of two to three weeks between the two operations, but the internal jugular vein should be removed on one side only. Probably the best radiological procedure is to follow this up a fortnight or so later by a prolonged external irradiation on the lines indicated in Class 1, but of course this is not an economical procedure with regard to beds or radium, and much will depend on local conditions and resources. It has been the practice in Manchester to implant from 10 to 15 needles of active length 15 mm., screen 0·8 mm. of

platinum, linear intensity 0·6 mgrm. radium element or 1·8 mc. of emanation, for seven days, in the wound but nothing like the same degree of homogeneous irradiation is achieved as by external irradiation, and of course the chances of sepsis are increased. Probably it is a sound procedure in all cases to implant a few needles close to the base of the skull, particularly when the primary lesion involves the fauces, lateral pharyngeal wall, or middle third of the tongue, as external irradiation is less likely to prove effective at this depth.

3. *Cases with Fixed Glands.*—It is doubtful whether external irradiation as commonly practised has ever 'cured' (in the five-year sense) a patient with fixed deposits in the neck secondary to a buccal carcinoma. Undoubtedly regression occurs, but so does recurrence, and the process cannot be repeated indefinitely, owing to the intolerance of the skin and to the immunization which follows non-lethal doses.

It is recognized that this question of immunization is not fully settled. However, if recurrence takes place in an area which has been irradiated, growth is often slower, and a fibro-neoplastic mass is formed, which is definitely more resistant to treatment. This may be due to the condition of the stroma. If irradiation is pushed, say, by a prolongation of the time period, the growth may disappear, but radio-necrosis is extremely probable.

Cade states that good palliative results follow the removal of as much of the growth as is possible surgically, combined with post-operative external irradiation, pushed to such an extent that the skin completely peels. In Manchester, this type of case, if not too advanced, has been treated exactly on the same lines as the primary growth, by implantation, and this is certainly worthy of trial if the palpable mass is limited to one group of glands.

If implantation is decided upon, incisions are made and flaps turned back as for a block dissection, and if the fixed glands are in the submaxillary or upper deep cervical groups, the sternomastoid is divided above the clavicle and reflected upwards. In this way a very good exposure of the anterior and posterior triangles of the neck is obtained, and accurate implantation is more easily performed. Usually needles are left *in situ* for a week, and removed under general anæsthesia. *Fig.* 312 is a diagram illustrating the implantation of needles in the wound after a block dissection has been performed. It is suggested that 0·8 mm. of platinum be used as a screen, so that only γ rays of short wave-length are employed. Concentration of needles is directed to the group of glands which is most involved. Probably post-operative irradiation by multiple sources on a 'collar' is preferable, but the method has advantages where large numbers of cases are being treated and supplies of radium are limited.
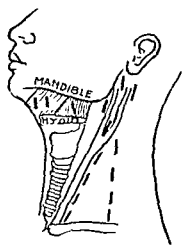
Fig. 312.—Illustrating the implantation of needles in the wound after block dissection.

Block Dissection.— No half measures should be adopted if surgery is decided upon. The removal of the internal jugular vein, together with the sternomastoid, is essential if a complete clearance of the gland-bearing area

is to be made. Not only does it enable this to be accomplished, but by giving better exposure it accelerates the operation. Regional anæsthesia or general anæsthesia is employed according to the preference of the individual surgeon, but it would appear that the former method might be carried out more frequently in view of the severity of the operation, and the fact that so many of the patients are over sixty years of age. If a block dissection is done on both sides, the internal jugular should be removed on the more affected side.

External Irradiation.—Cade recommends a Columbia paste collar 15 mm. in thickness. On it, and screened by 1 mm. of platinum or its equivalent in other metals, are disposed multiple foci containing 1·33 to 2 mgrm. of radium element and linear intensity 0·66 mgrm. In all about 50 to 70 mgrm. of radium element will be required. For post-operative irradiation seven to ten days' exposure for each side is about the average, but where the incomplete surgical eradication has been performed fourteen to twenty days' exposure will probably be required. It is impossible to be quite so definite with this method as with the primary site in detailing technique.

In prophylactic post-operative irradiation desquamation of the skin is the aim, but in the third class with fixed, inoperable deposits complete peeling is desirable.

From the above considerations it will be obvious that the purely radiological treatment of the lymphatic drainage area is not on a satisfactory · basis. We feel that this is largely due to restricted supplies of radium and to the method employed. (If we consider the theoretical principles underlying treatment, implantation and surface application have considerable disadvantages.) Expediency must necessarily weigh most in the treatment of the individual; but the ideal method which must be tried, in the hope that greater quantities of radium may be forthcoming, is the employment of a large quantity of radium at a distance, which discounts both the human element and the physical disadvantages of current methods.

RESULTS OF TREATMENT.

The results of treatment vary as one considers the primary lesion only or the cases as a whole.

There are no five-year figures available in this country, but Continental workers report about 45 per cent of five-year cures as regards the primary site, and 20 per cent of absolute cures. When one takes into account the fact that all cases treated are reckoned, and that a large proportion were hopelessly advanced at the very beginning, these are remarkable figures. It is particularly pleasing, too, that the percentage of recurrences at the primary site is very small, if a high standard is set with regard to cases deemed 'cured'.

The functional results are almost perfect, especially in the tongue. Mobility is scarcely impaired, and only slight defects are noted when the tongue is protruded fully. In general, if the lesion is unilateral, the tongue is deviated as a whole to the side of the lesion, and the tip points to the opposite side (*Figs.* 313, 314).

Even as a palliative procedure for the primary growth radium has amply justified itself as a therapeutic measure. The end of those patients who die of an untreated and unchecked primary growth is most distressing; death from metastatic complications is comparatively peaceful.

FIG. 313.—Photographs showing the good functional results after treatment. They were taken in March, 1928, and were selected only for the reason that the patients resided locally. All except one patient, who died of intercurrent disease, are still alive and well. A minor point of clinical interest is that, with a unilateral lesion, the tongue as a whole is drawn towards the affected side, whilst the tip points in the opposite direction. Before treatment the tip usually points to the same side as the lesion. In five of these cases there was microscopical evidence of deposits in the lymphatic glands. (*Reproduced by kind permission of the Editor of the 'Lancet'.*)

The table on p. 516 has been taken from an article by Regaud in the *American Journal of Roentgenology and Radium Therapy*, vol. xxi, January.

1929, No. 1. Unfortunately this does not give a true view of the situation, as percentage figures for all cases treated between 1920 and 1926 are given. The year 1922 is that on which the latest five-year figures can be based.
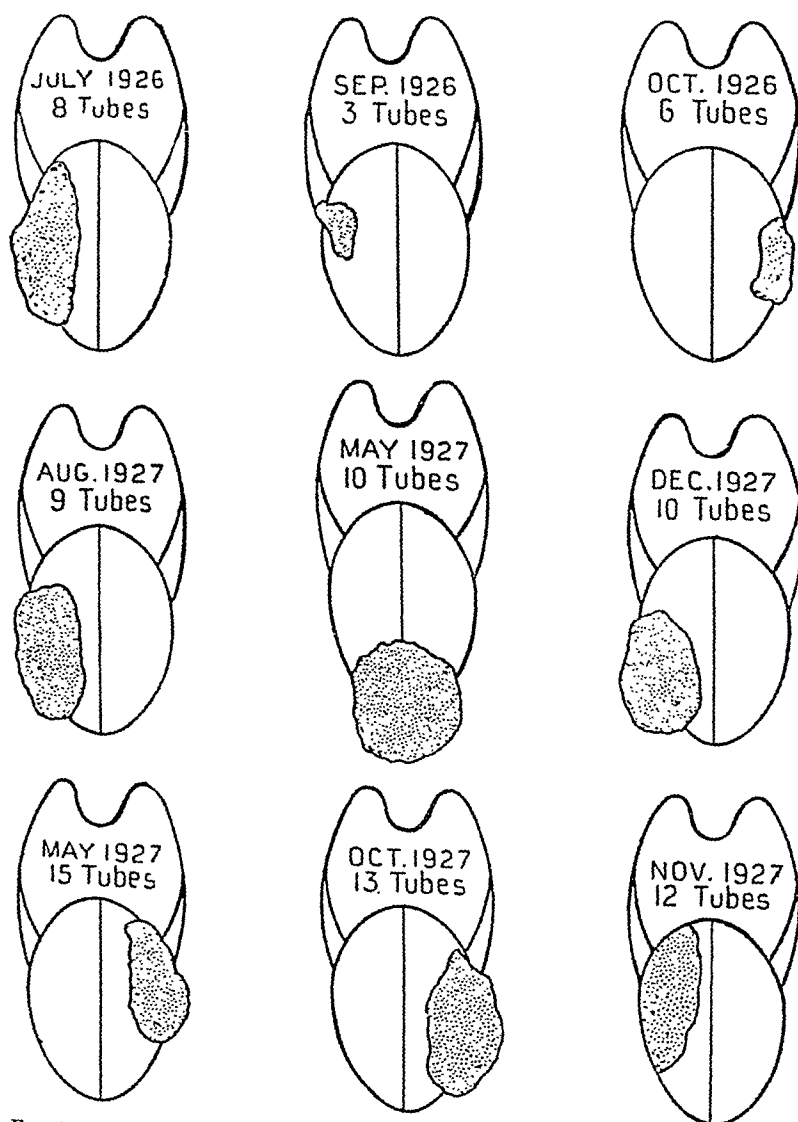
FIG. 314.—Key to the photographs shown in *Fig.* 313. All were moderately advanced cases with the exception of 2 and 3. (*Reproduced by kind permission of the Editor of the 'Lancet'.*)

The following table, which has been compiled from the one overleaf, gives the percentage figures for complete cure as assessed at the end of December, 1927 :—

		1922	1923	1924	1925	1926
Total	..	33	54	55	60	54
Complete cure	..	6	10	11	17	21
Percentage ..	..	18·18	18·50	20·00	28·33	38·88

CANCERS OF THE TONGUE AND OF THE FLOOR OF THE MOUTH. TOTAL STATISTICS OF TREATED CASES AND RESULTS, 1920–6.

(Revised Dec. 31, 1927.)

	1920	1921	1922	1923	1924	1925	1926	TOTALS	PERCENT-AGE
Number of treated cases ..	55	41	35	56	59	65	56	367	
Cases which were eliminated..	2	6	2	2	4	5	2	23	
Cases retained for statistics ..	53	35	33	54	55	60	54	344	
1. Anterior dorso-lingual localization	20	22	19	24	34	39	27	185	
a. Complete cure	5	6	3	6	9	9	11	49	26·4
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	6	7	8	10	7	4	4	46	24·8
c. Failure to arrest primary lesion of tongue ..	9	9	8	8	18	26	12	90	48·6
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	95	51·3
2. Posterior dorso-lingual localization	16	5	6	18	14	12	11	82	
a. Complete cure	1	2	3	1	2	3	4	16	19·5
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	2	0	0	5	4	2	1	14	17·0
c. Failure to arrest primary lesion of tongue	13	3	3	12	8	7	6	52	63·4
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	30	36·5
3. Infra-lingual localization ..	17	8	8	12	7	9	16	77	
a. Complete cure	0	3	0	3	0	5	6	17	22·0
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	3	2	0	1	2	0	1	9	11·6
c. Failure to arrest primary localization	14	3	8	8	5	4	9	51	66·2
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	26	33·7
4. All localizations combined..	53	35	33	54	55	60	54	344	
a. Complete cure	6	11	6	10	11	17	21	82	23·8
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	11	9	8	16	13	6	6	69	20·0
c. Failure to arrest primary lesion of tongue	36	15	19	28	31	37	27	193	56·1
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	151	43·8

From these figures it appears that if a patient survives three years without recurrence there is a reasonable chance of permanent cure.

In Manchester our figures for 1926, 1927, and 1928, which correspond practically with those for 1924–6 in Regaud's series, are as follows :—

			1926	1927	1928
Complete cure ..	..	..	18	25	51
Total ..	..	..	80	74	113
Percentage	..	..	22·50	34·7	45·13

These figures include all localizations in the mouth : Regaud's figures include only the tongue, infralingual surface of the tongue, and floor of the mouth.

I am indebted to Miss D. Davidson for the coloured drawings in the text.

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EXAMINATION OF MATERIAL REMOVED AT FIRST OPERATION.—The tumour masses were of a firm consistency and presented a greyish-white appearance, with many areas of hæmorrhage. Microscopically the sections show masses of small round or polyhedral cells, separated by fibrous tissue septa, and interspersed with small areas of hæmorrhage (*Fig.* 317). Under a higher
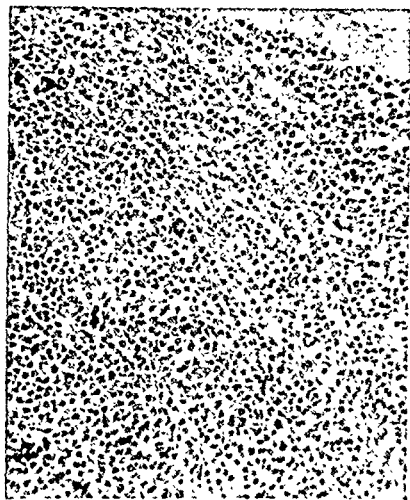

FIG. 317.—Low-power photomicrograph of tissue removed at first operation, showing general arrangement of tumour cells.
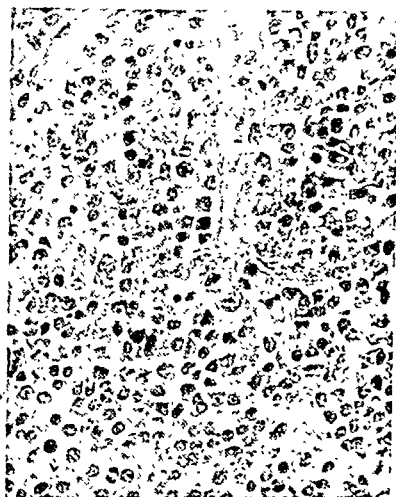

FIG. 318.—High-power photomicrograph of tumour, showing typical cell appearance and scanty stroma.

magnification (*Fig.* 318) the cells are on the whole discrete and separated from each other by a scanty matrix, but exhibit a tendency to form short columns.

FIG. 319.—Material removed at second operation, consisting of granulation tissue, with round-cell infiltration and islands of plasma cells and lymphocytes.

They are polyhedral in shape, and possess a round or oval nucleus situated eccentrically. The cytoplasm of the cells is amphophilic and non-granular ; and the nucleus, staining well with hæmatoxylin, is of a typical ' cart-wheel ', or ' clock-face ', type. Few mitoses are seen and no multinucleated cells. A few of the cells show degenerative changes, such as swelling, vacuolation, loss of nuclear outline, and disappearance of the nucleus. Staining with the Unna-Pappenheim method is typical, and a diagnosis of myeloma of plasma-celled type was made.

A blood-count showed only a mild secondary anæmia, with no abnormality in the red or white cells. No Bence-Jones proteosuria could be demonstrated. X-ray examination of the skeleton did not reveal any other foci of tumour formation.

EXAMINATION OF MATERIAL REMOVED AT THE SECOND OPERATION.—
The portions of tissue removed from the cavity vary slightly from a structureless matrix to well-formed fibrous tissue and vascular granulation tissue. Islets of plasma cells, lymphocytes, and small round cells are found in most of the sections, but there is no structural resemblance to the tumour formation originally present (*Fig.* 319).

EXAMINATION OF THE MATERIAL REMOVED AT THE THIRD OPERATION.—
The material appears to be entirely necrotic except for areas of fibrous tissue containing chronic inflammatory cells. There is no histological evidence of new growth.

APPEARANCE OF THE FEMUR AFTER AMPUTATION (*Figs.* 316, 320).—The specimen consists of the lower three-quarters of the right femur. In the middle third of the shaft there is a fusiform swelling measuring $4\frac{1}{2}$ in. long and $2\frac{1}{4}$ in. at its greatest diameter. This enlargement is formed by a shell of bone, in some places no thicker than parchment, constituting the walls of a cavity originally occupied by the new growth of the marrow, and now devoid of contents. In some places the bony shell appears to have been perforated, the periosteum alone forming the capsule of the growth at these points.

On the antero-external aspect the soft tissues, including the partially healed skin incision, have been left adherent to the margins of the cavity from which the tumour was removed. The shaft of the femur above and below the bony swelling is normal in size and structure.
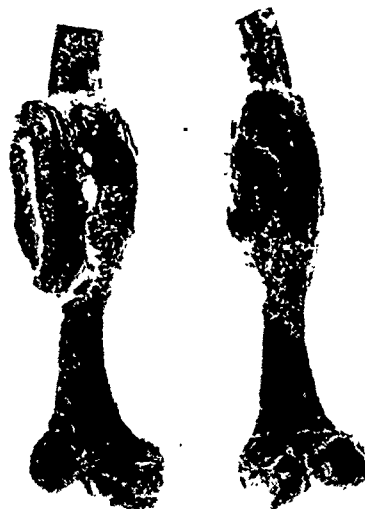

FIG. 320.—The lower two-thirds of the femur after amputation, showing fusiform swelling and original incision through the soft tissues.

COMMENTS.

While multiple myeloma of plasma-celled type is of comparatively common occurrence, cases showing one solitary focus of new growth appear to be very rare. Aschoff[1] refers to cases recorded by Kunosoki and Frank. Kolodny[2] (1927) states that only one case is recorded in the Registry of Bone Sarcoma of the American College of Surgeons, and Ewing[3] (1928) does not refer to their occurrence in his *Neoplastic Diseases,*. Shaw[4] (1923) has published an account of a case which was completely cured by bone-grafting after excision of the segment of bone affected by the new growth. Stewart and Taylor[5] (1928) investigated a number of cases of plasmocytoma ; in one case a second focus of growth appeared in the frontal bone after the original myeloma had been removed from the maxilla, and disappeared under X-ray treatment.

The solitary plasma-celled myeloma is a new growth which arises in the

bone-marrow, and appears to occur more frequently in the long bones than in flat bones or vertebræ.   The origin of the tumour is still a matter of dispute ; the type cell is believed to be derived either from a lymphocytic cell or from the perivascular endothelium.

Ewing's sarcoma may be mistaken for myeloma when sections are overstained with hæmatoxylin (Kolodny, 1927), and plasma cells may be found in these tumours.   Ewing's sarcoma, however, is an endothelial tumour, and, according to Ewing[6] (1924), is probably derived from perivascular lymphatic endothelium.

In the case of plasma-celled myeloma recorded in this paper the histology of the reparative process after removal of the new growth is of interest, especially regarding the use of radium.   It seems probable that the use of radium in large doses has brought about a condition of ' radium necrosis ', which has not only prevented any attempt at recurrence on the part of the tumour tissue but has placed the natural reparative reactions of the healthy structures in abeyance.   The possibility of such an eventuality must evidently be kept well in mind when radium is employed, as the clinical evidence of the necrotic influence may be delayed for ten days or a fortnight.

I am indebted to Mr. Hey Groves for permission to make full use of his clinical notes, to Dr. A. L. Taylor for his help and advice in the investigation of the histological material, and to Dr. G. B. Bush for the skiagram.

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THYROID METASTASES IN BONE.

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THE subject of this paper is an extremely controversial one, to be approached only with an open mind and in a spirit of inquiry. Its importance, however, can scarcely be denied, touching as it does on the vital question of whether or not benign tissues can disseminate. According to most accredited pathologists, dissemination is a feature of malignant tumours and of these alone ; but to challenge accepted views is sometimes instructive and is always of interest. It is a truism that no convincing definition of malign, as opposed to innocent, tumours exists ; and, in place of a definition, we have to content ourselves with mere tabulated lists of characteristics supposed to be pathognomonic of the two classes of neoplasm.

My interest in thyroid osseous metastases has recently been quickened because within the past two and a half years I have encountered two such cases in Tanganyika Territory.

CASE REPORTS.

Case 1.—An African woman, age about 50 years, was admitted to Songea Hospital (situated about one hundred miles from Lake Nyasa) on Sept. 2, 1926. She had a large, soft, fleshy lump on the back of the left side of the head ; it was adherent to the skin and covered with a network of enormously dilated veins. She complained of considerable pain in the region of the lump ; there was no enlargement of the cervical glands. There was a small, hard, apparently completely encapsuled lump, of about the size of a walnut, in the right lobe of the thyroid gland ; it had no features suggestive of malignancy, and the patient, though aware of its existence, had thought it too trivial to bring to my notice. She said that her thyroid lump had first appeared about three years previously and that the cranial lump had begun to develop about one year later. The latter had been of very slow growth. When seen by me it was the size of a very large orange. I tried to obtain a wedge of the tumour for section, but hæmorrhage was so furious that I had to abandon the attempt. The tumour was thus of an intensely vascular nature.

In the usual manner of Tanganyika natives, my patient, when she realized that there was no likelihood of a sudden and dramatic cure being produced, soon absconded from hospital.

It may be objected in this case that the cranial tumour may have been a primary malignant growth, the thyroid swelling being merely a coincidence. It is unlikely, however, that a primary malignant tumour of the skull could have existed for two years without at least fungating.

Case 2.—An African woman, of the Mkami tribe (Morogoro district), age about 45 years, was admitted to the Sewa Hadji Hospital, Dar-es-Salaam, on Feb. 21, 1929, complaining of a large and painful lump on the back of the head of three years' duration. There was a fleshy mass about the size of an ostrich's egg projecting

from the occipital region of the skull (*Fig.* 321). It was apparently fixed to the sub-jacent skull and the scalp could not be moved over it. There were dilated veins in the overlying skin. Further examination revealed that there was a hard and slightly nodular lump (of hen's egg size) in the left lobe of the thyroid gland. This lump was freely movable on the deep structures and was quite unattached to the skin ; it rose and fell freely on deglutition. Apart from its hardness and its slightly nodular surface, it had no features of malignancy whatever. In the right subclavian triangle I found a hard and somewhat fixed gland of about walnut size ; but apart from this no enlargement of the cervical glands could be detected. The patient apparently attached no importance whatever to her neck condition, and could scarcely conceal her impatience when I examined it and questioned her about it. She said that she had had a lump in her neck ever since childhood, but that it had never caused trouble. She could not say that this lump had recently been increasing in size.
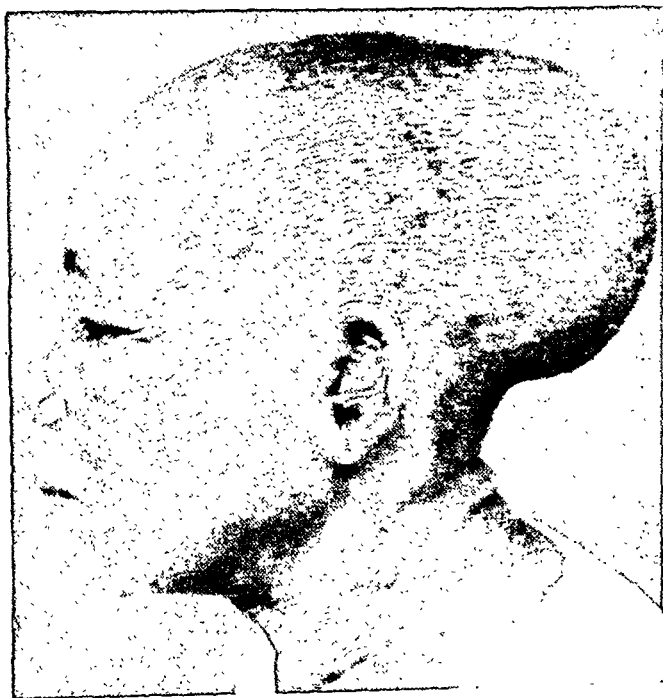

FIG. 321.—*Case* 2. Appearance of the tumour.

Mr. J. E. Brunnen, of the Electricity Department, very kindly radiographed the skull for me. The X-ray picture shows that the outer table, diploë, and a part of the inner table of a considerable portion of the occipital region of the skull had been destroyed and replaced by growth (*Fig.* 322); expansion had, however, been chiefly at the expense of the outer table.

On March 18, I removed a wedge of the tumour for section. The growth had an appearance as of encapsulation, but as the 'capsule' was extremely hard and difficult to cut, I formed the impression that it was really the thinned-out relic of the outer table of the skull. The tumour itself was extremely pale and of a rather waxy appearance.

This patient followed the example of the previous one in absconding from hospital before the condition could be further studied. There was, in any case, little to be done for her. Excision of the tumour would have entailed removing the whole of the occipital region of the skull.

Fig. 322.—*Case 2.* Radiograph showing destruction of part of the occipital region of the skull.
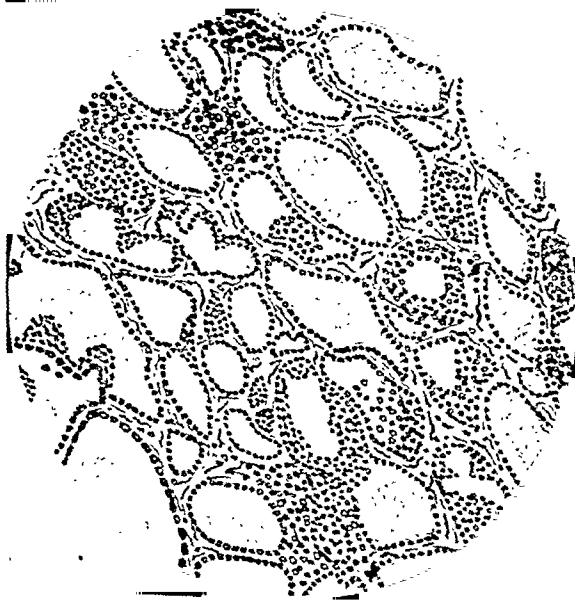

Fig. 323.—*Case 2.* Microscopic appearance of tissue removed.

Dr. H. O'D. Burke-Gaffney, of the Dar-es-Salaam Laboratory, examined the portion of tissue which I had removed. His report was as follows :—

" The structure of the tumour mostly resembles the type of fœtal adenoma. There are numerous empty tubules, surrounded in part by a vascular stroma. Some of these are dilated and contain secretion. In other parts there are irregular acini containing true colloid. Between these in some areas are masses of cuboidal cells which do not form acini. The tumour would appear to be an adenocarcinoma— subsequent to a fœtal adenoma which has developed malignant changes. Such a diagnosis is made chiefly from the metastatic nature of the growth. The essential histological changes mostly resemble both simple and fœtal adenomata. It would be difficult to identify a carcinomatous element from the appearance only." (*Fig. 323.*)

GENERAL FEATURES.

The occurrence, in or on bones, of tumours containing thyroid tissue has long been recognized, but the nature and origin of these deposits have given rise to much speculation. That they can occur as 'orthodox' metastases in cases of unequivocal thyroid cancer is undoubted, Pemberton[1] assessing the incidence at 6 per cent, while Ewing[2] holds that cancer of the thyroid is second only to that of the breast and prostate in the production of skeletal secondaries. Their relation, however, to the phenomenon of 'general thyroid malignancy' at once presents us with a problem which has never yet been solved. That tumours structurally identical with the thyroid gland can appear in the bones of patients whose thyroids are, judged clinically, either normal or else the seat of a simple growth or goitre, is a fact not easily explained ; and what Jacobson[3] has called 'the mysterious malignant adenoma' has so far baffled pathology. However produced, these deposits are oftenest found in women of from 40 to 65 years of age.[3]

The skull bones are the commonest sites for these growths, but they have also been found in the sternum, vertebræ, ribs, humerus, femur, pelvis, and clavicle, and approximately in that order of frequency.[2] Thyroid 'rests' or inclusions may possibly explain a few cases, but it is a fact that the bones least likely to contain aberrant thyroid tissue are the ones most commonly attacked by 'metastasis', and even the clavicle and sternum are developed in a plane altogether anterior to that of the thyroid *Anlage.*

Thyroid metastases make their first appearance, as a rule, in the vicinity of the cranial sutures or of the epiphyses of the long bones.[2] They may be encapsuled or diffuse, endosteal or periosteal, and they are sometimes osteoplastic, so that a pathological fracture due to their presence may ultimately unite.[2] They have often been mistaken for primary sarcomas of bone.[2] Some are pale and almost bloodless (as in *Case 2*), while others are so intensely vascular and display such vigorous pulsation that they have been mistaken for aneurysms. Cramer was thus misled by a sternal deposit, which he treated by ligature of some of the great vessels. (*Case 1* was intensely vascular, but it did not pulsate.) Many of these deposits function after the manner of the thyroid gland—for example, in one of Eiselsberg's cases, ' tetany' (? cachexia strumipriva) followed the removal of a carcinomatous thyroid, was relieved when a secondary appeared in the sternum, and reappeared when the sternal growth was excised.[2] Ewald has shown that, in some cases of thyroid adenocarcinoma which are iodine-free, iodine has been detected in an osseous deposit.[2]

A thyroid osseous metastasis is usually slow in its growth. It had existed for two years in *Case* 1 and for three in *Case* 2. In a case of Halpérine's the metastasis had been present for twenty years—a fact which might well throw some doubt on its malignant nature.[4]

Ehrhardt maintained that thyroid osseous metastases were *never* single, and that multiple deposits were always to be found in cases that came to autopsy. He therefore considered that their surgical treatment was useless.[2] Joll,[4] on the other hand, says that the osseous growth may be the sole metastasis present in the body, and that "this has been confirmed by careful post-mortem examinations". He has not, however, quoted a single case to support this contention, nor have I been able to find any proof of it in the literature at my disposal.

The histology of thyroid metastases is extremely varied and often 'mixed' ; so that their structure may be that of a carcinoma, an adenocarcinoma, a 'foetal adenoma', a simple parenchymatous or colloid goitre, normal thyroid gland tissues, or combinations of any two or more of the foregoing.

DIAGNOSIS.

These growths are specially liable to be mistaken for primary sarcomas ; diagnosis, except by the microscope, may be impossible. Radiography can do little more than establish the neoplastic nature of the bony swelling, though of course a periosteal sarcoma might show a definite 'skeleton'. Trotter[5] warns us that "a diagnosis of primary malignant disease of the skull should never be made until the presence of malignant disease elsewhere has been excluded. Examination should be directed especially to the thyroid, kidney, breast, and prostate". One would strongly suspect a thyroid origin in the case of bone growth affecting an elderly woman with some pathological condition of the thyroid gland, particularly if the breasts were normal.

With a metastasis in the skull (the commonest site for such deposits), we would have to eliminate sarcoma (remembering that periosteal sarcoma is the commonest primary tumour of the skull) ; ivory osteoma ; cerebral meningioma involving the skull by direct extension ; inflammatory hyperostosis—perhaps syphilitic ; dermoid cyst ; lipoma ; meningocele and the allied conditions ; hæmatoma ; and subpericranial abscess. Most of these could be rapidly excluded. A deposit in the sternum might closely simulate aortic aneurysm (as in Cramer's case) ; whilst a vertebral deposit causing angular curvature and paraplegia (as in cases reported by Horsley and Hebbs) might easily be confounded with Pott's disease of the spine.

The nature of both my cases was strongly suspected from the beginning. I unfortunately lacked facilities for establishing the diagnosis of *Case* 1, but in *Case* 2 the metastasis was examined both by radiography and by the microscope.

PROGNOSIS AND TREATMENT.

Bland-Sutton[6] says : " In many instances these secondary tumours have been subjected to operative treatment, and on the whole with satisfactory results ", a statement which is borne out by the cases which Joll has recorded —notably Kraske's case in which there was no recurrence after eight years.

A good deal probably depends on whether or not the metastasis is single, and though Ehrhardt maintained that this was never the case, he was probably too pessimistic. Barthels[7] states that "a primary malignant tumour of the thyroid gives a worse prognosis than a metastatic growth", and it certainly appears that the type of thyroid carcinoma which produces bone deposits is unusually 'chronic' and of relatively low virulence.

In the present state of our knowledge it would probably be good practice to remove a single bone metastasis, provided the risk was not excessive, and to follow this up with thyroidectomy. Prophylaxis is, of course, a matter of removing the 'pre-malignant adenoma'. In other words, all tumours of the thyroid should be suspect and their treatment should be that of a potentially malignant growth.

SUMMARY.

1. The discovery, within a short period, of two cases of thyroid bone metastases, affecting natives of the Tanganyika Territory, is a fact of some interest.

2. The general features of thyroid osseous metastases are discussed.

3. The view is taken that all such cases are probably dependent on the presence of a thyroid carcinoma, which, however, may be so atypical, so slow and insidious, that its true nature is apt to be overlooked.

4. It is incredible that a malignant thyroid can produce a benign metastasis.

5. The suggestion that a benign thyroid may produce either a benign or a malignant metastasis is less unreasonable, and is certainly supported by a good deal of incomplete clinical and histological evidence. At present we can only return a verdict of 'not proven'.

6. Where the risk is not excessive and the metastasis is apparently single, the treatment recommended is excision of the metastasis, followed by thyroidectomy.

7. Prophylaxis depends on removing all thyroid tumours as soon as recognized.

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THE ANATOMY (COMPARATIVE AND EMBRYOLOGICAL) OF THE SPECIAL THYROID LYMPH SYSTEM, SHOWING ITS RELATION TO THE THYMUS:

WITH SOME PHYSIOLOGICAL AND CLINICAL CONSIDERATIONS THAT FOLLOW THEREFROM.

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THE lymphatic system of the thyroid has attracted the attention of the anatomist from the earliest time. The reason for this is in itself significant. The thyroid is the only gland in which under natural conditions the lymphatic system is found with great frequency to be active and distended with lymph and lymphocytes. The histologist, therefore, had not to await the results of injection and experiment to demonstrate the lymph system in the thyroid gland.

THE INTRA-THYROIDAL LYMPH SYSTEM.

Lymph spaces within the thyroid have been described in particular by Boechat[1] in 1873, Biondi[2] in 1888, Hürthle[3] in 1894, Müller[4] in 1896, Régaud and Petitjean[5] in 1909, and by Matsunaga[6] in 1909. Boechat's[7] description still stands to-day as comprehensive :
". . . on a, en effet (dans le corps thyroïde) un épithélium réposant sur un endothélium, mais il est à remarquer qu'ici l'endothélium sous-épithélial fait partie d'un sinus lymphatique". In our first study of the gland[8] we confirmed Boechat's view. Each follicle of the thyroid lies in a lymph space so arranged that the thyroid epithelium is bathed directly by any lymph contained therein (*Fig.* 324). Groups of such follicles with their perifollicular spaces are enclosed in a fibro elastic capsule lined by endothelium (*Fig.* 324). Within the limit of this lining endothelium the perifollicular spaces are continuous one with another, forming slit-like channels
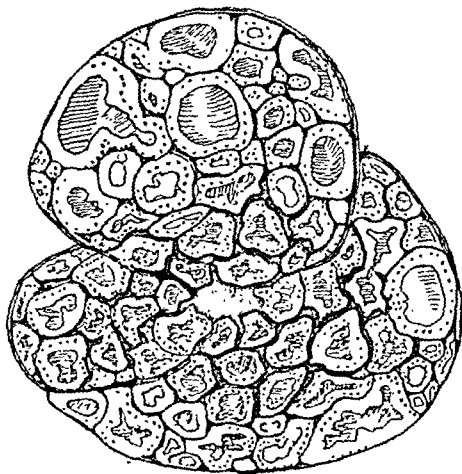

FIG. 324.—Drawing of three encapsuled groups of follicles showing their perifollicular lymph spaces or sinusoids emptying into a common central lymph space—the intra-lobular lymphatic.

running between the individual follicles. These channels are portions of the endothelial-lined sac rendered visible by fluid contents. It is to this endothelial sac with all its tortuous interfollicular channels that we have given the name " *lymph sinusoid*." Each lymph sinusoid within which are packed columns of thyroid epithelium and a blood-capillary plexus represents one " *gland-unit*."* Groups of these encapsuled gland-units are regularly clustered about a central lymphatic channel into which their sinusoids open freely (*Fig. 324*). They are bunched around this channel like grapes about a stalk. Each bunch of gland-units forms a lobule of the gland and is enclosed in a special compartment of the interstitia.[9]

This arrangement is an analogous one to that found in the liver lobule.† In the liver, groups of blood sinuses, each containing columns of liver epithelium, a 'Kupffer cell plexus'‡, and blood sinusoids are clustered about a central vein, the hepatic vein; into this vein the portal blood sinusoids open. The difference in structural arrangement between these organs is that in the thyroid *lymph takes the place of portal blood*. From this it is safe to infer that the lymph is as significant to thyroid function as the portal blood is to liver function.

The Interstitial Lymph Channels.—Let us follow the course of the thyroid lymph from these lobules through the gland. The central intralobular lymph channels which receive their lymph from the sinusoids leave the lobules and unite in the interstitial tissue of the gland. Here again we find a peculiarity about the arrangement of the specific lymph-vessels. They run in the course of the branches of the main artery to the gland, the inferior thyroid artery.[13] From the gland they emerge as a number of discrete trunks on the postero-mesial surface of each lobe at the well-marked hilum—that is, at the point of entry of the inferior
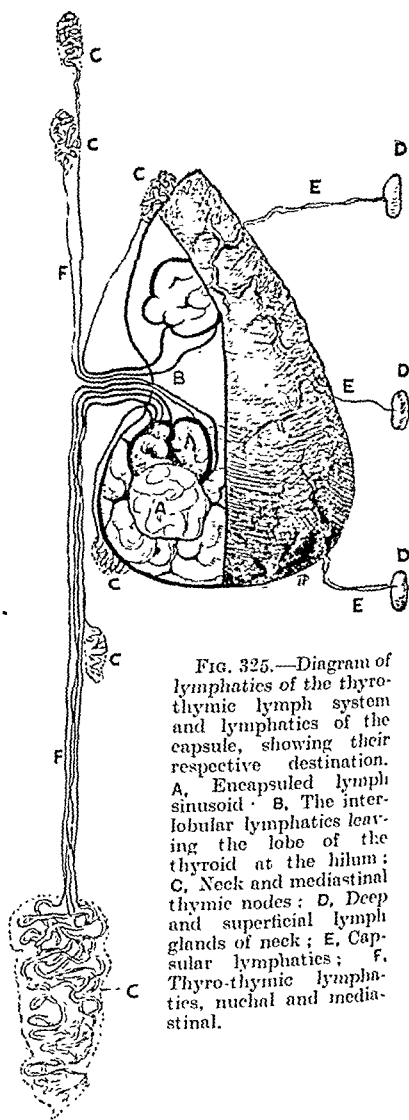

Fig. 325.—Diagram of lymphatics of the thyro-thymic lymph system and lymphatics of the capsule, showing their respective destination. A, Encapsuled lymph sinusoid · B, The interlobular lymphatics leaving the lobe of the thyroid at the hilum; C, Neck and mediastinal thymic nodes : D, Deep and superficial lymph glands of neck ; E, Capsular lymphatics ; F, Thyro-thymic lymphatics, nuchal and mediastinal.

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* By gland-unit we mean the unit-area of associated tissues (epithelium, blood capillaries, lymph spaces, etc.) necessary for the exercise of the specific function of any gland.[8]

† According to Delépine,[10] Mall,[11] and McNee.[12]

‡ The Kupffer cells of the liver sinusoids are reticulo-endothelial cells and similar in every way to the reticulo-endothelial cells of the thyroid sinusoids. (*See* Williamson and Pearse, *Jour. Pathol. and Bacteriol.*, 1926, xxix, 167.)